NATURE

No. 4146 SATURDAY, APRIL 16, 1949 Vol. 163

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THE BRITISH SCIENTIFIC INSTRUMENT INDUSTRY

ON two occasions during the latter half of the war period, attention was directed in these columns to the important contribution which the scientific instrument industry would be called upon to make towards the rehabilitation of every phase of life in Great Britain, and to the achievement of normal national prosperity. The experience of the post-war years has shown that the demands made upon the manufacturers of scientific instruments have not merely been heavy; but, in consequence of the necessity imposed by economic circumstances for an accelerated achievement of industrial production and efficiency greatly in excess of pre-war standards, even more arduous than had been anticipated. The manufacturers of scientific instruments were, in common with members of many other industries, completely immersed in the war effort, and had not the opportunity—nor were they permitted—to indulge in any post-war planning. It is appropriate, therefore, at this distance from the termination of the War, to review the position and condition of this vital industry and to assess its ability to meet the very heavy responsibilities which still rest, and will continue to rest, upon it.

It is well to remember that the functions of a scientific instrument industry are far more complicated and diverse than was the case a generation or so ago. At that time, the predominant activity of the manufacturer of scientific instruments was concerned with the provision of instruments for educational, laboratory and research purposes. The main commitment of the instrument maker was to meet the demands of pure science; and, as a consequence, not only was there intimate contact with the world of science, but also something of the laboratory atmosphere permeated the scientific instrument works. To-day, while the fulfilling of the requirements of pure science remains a vital function of the instrument industry, yet the greatest demands for instruments come from the world of applied science, and in particular of industrial science. It should also be borne in mind that the scientific instrument industry is not a single industry, but is, in fact, a collection of several individual industries. The techniques of manufacture of the microscope maker have little in common with those of the maker of electrical instruments. The problems of the manufacturer of instruments of metrology differ markedly from both. This lack of common ground in manufacturing technique between different classes of instruments connotes an equal diversity in the scope of development work required to be undertaken by the industry, and it is not always realized that the total development effort of the industry has to be divided into numerous classes of development projects which are as diverse in their nature as are instruments themselves. The magnitude of the development field which has to be covered by the manufacturers of scientific instruments cannot be over-stressed, for much of the impatience which is more than occasionally shown towards the scientific

instrument industry arises from the complete pre-occupation of a particular section of users with a particular class of instrument, and a consequent—and, let it be said, understandable—over-estimation of the proportion of the total development capacity of the industry for dealing with particular development projects. Nevertheless, the ability to produce new instruments and to modify existing types of instruments to meet new and urgent requirements does provide the 'acid test' of the efficacy of the instrument industry and the main symptom of the state of its health. It is, however, appropriate that a timely reminder should be given of the onerous nature of the instrument maker's commitments in the development field, and to remark that only a very flourishing scientific instrument industry can hope to meet those commitments with adequacy.

Opportunities have occurred in the displays of instruments at successive British Industries Fairs, in the annual exhibitions sponsored by the Physical Society such as that held in London during April 5–8 at the Imperial College of Science and Technology, and in the trade shows at Stockholm and Copenhagen, of judging the progress made by the scientific instrument industry of Britain, which, it can be said without much exaggeration, had almost to make a fresh start at the conclusion of the War. At the Copenhagen exhibition, the comments on British instruments were most favourable, and some sense of astonishment was expressed by Scandinavian users, whose practice it had been to obtain all their instruments from the Continent, at the range of instruments shown and at the excellence of their design. There can be little doubt that there is no longer any substantial measure of validity in the criticism so often levelled at the scientific instrument industry of Britain in the past, that it exhibited weakness in its design and engineering activities. A comparison of post-war and pre-war British instruments cannot but reveal that remarkable progress has been made, and clearly indicates the very considerable effort which has been made by scientific instrument makers. These developments have occurred at a time when instrument manufacturers have been called upon to make the greatest possible effort to increase the export trade in instruments. At the moment, British scientific instruments to the value of £10,000,000 a year are being exported, as compared with some £2,000,000 before the War. This diversion of instruments abroad has necessarily had an unfavourable impact on the dates of delivery of instruments to the user in Great Britain.

The effort which the industry has already made to revive its production of civil instruments after its long pre-occupation with military requirements, and to assist the general economy of the country by making its contribution to the export drive, has undoubtedly and inevitably placed some limitation on the magnitude of its development effort. In consequence, it has not been found possible for the instrument maker to meet in every case the eager demand of instrument users for new and particular types of instruments; yet the addition which a considerable export trade has made to the resources of the industry ought to mean that all users' requirements should be met in an increasingly adequate degree. There is little need to stress the vital character of the part which, in this technological age, instrument production plays in the life of an industrial nation, and the increasing dependence of the work of the men of science on the provision of specialized instruments. The ability of the scientific instrument industry to play this part is, however, dependent upon its total volume of trade, and the recent expansion of its export trade was welcomed as offering potential resources which would enable the provision of scientific instruments in Great Britain to be achieved in a more worthy and complete manner than ever before. The revival of the German scientific instrument industry, in economic circumstances which are particularly favourable to that revival, does therefore create a problem, the solution of which demands serious attention. The official prognosis is that the trade in British instruments must inevitably shrink; this, in the long run, can only mean that the ability of the instrument manufacturer to meet, through his research and development activities, the continuous and varied requirements of instrument users in Great Britain, must correspondingly decrease. Such a situation cannot be faced with equanimity, since its repercussions are so vital and so widespread. The soundness of the reasons which have compelled the Allied control authorities in Germany actively to assist industrial revival is patent. The implications of that revival in respect of the ability of the British scientific instrument maker adequately and abundantly to produce scientific instruments, which provide the means of scientific research and the key tools of industrial efficiency—and ultimately profoundly affect the amenities and standard of life—should, however, not be forgotten. The problem is more complex than appears at first sight, and should be given very serious and practical thought.

CARBOHYDRATE CHEMISTRY

Chemistry of the Carbohydrates

By William Ward Pigman and Rudolph Maximilian Goepp, Jr. Pp. xvii+748. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 10.80 dollars.

The Chemistry of the Polysaccharides

By Dr. Robert J. McIlroy. Pp. vii+118. (London: Edward Arnold and Co., 1948.) 10*s.* 6*d.* net.

An Introduction to the Chemistry of Carbohydrates

By John Honeyman. Pp. vii+144. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 15*s.* net.

FEW fields of investigation in organic chemistry have shown more rapid or more spectacular advances than has been the case with the carbohydrate group. Once methods had been developed for precise structural determinations of the monosaccharides and disaccharides and their derivatives, a vast range of natural products became open for detailed study. The position then reached (1929)

was depicted in Sir Norman Haworth's classical memoir "The Constitution of Sugars". Since that time the carbohydrate group has been the subject of continuous and intensive investigation by physical, chemical and biochemical methods, with the result that considerable further insight has now been gained into the molecular structure of the polysaccharides, including celluloses, starches, glycogens, pectic materials, plant gums and mucilages, and bacterial polysaccharides.

These developments in the chemistry of complex substances of high molecular weight are by no means the whole story. The simple sugars also have shown an amazing versatility of reaction and, selecting only one or two examples, we may recall the progress made in the study of the anhydro-sugars, the sugar alcohols, ascorbic acid and its analogues, and the amino-sugars. Much has been learned also of the behaviour of sugars towards enzymes, notably in regard to the mechanism of alcoholic fermentation and muscular contraction, and concerning the enzymic synthesis and break-down of amylose, amylopectin and glycogen. There is, therefore, an urgent need for new text-books which will incorporate these recent advances, and the books now under review may be taken as representative of three different approaches to the problem of recording knowledge in this field.

"Chemistry of the Carbohydrates", by W. W. Pigman and R. M. Goepp, is a large-scale monograph which provides a comprehensive survey of the broad field with full literature references up to 1946–47. It contains a wealth of information, including details of historical developments, and will be indispensable to all postgraduate students and research workers on the carbohydrate group. The material is clearly and accurately presented with adequate diagrams, and very little that is of importance in carbohydrate chemistry has escaped the authors' notice. The book, however, does not claim to be as comprehensive and detailed as the "Tollens–Elsner Handbuch" of 1935, and, from the point of view of the research worker, it is not so conveniently arranged. The difficulty seems to be that the authors have attempted to combine in one volume the features of a reference book with those of a large-scale text-book, with the result that, despite the careful and elaborate system of indexing, it is often difficult to track down a particular item of information. One could cite, for example, the way in which references to partially methylated sugars are scattered through the volume, while in the chapter which is designated "Ethers, Anhydrides and Unsaturated Derivatives" little collected information on the methyl ethers is provided. As a test case, let the reader attempt to ascertain from the book how to prepare 4-methyl glucose. The volume does, in fact, contain a literature reference pointing to this topic, but it appears unexpectedly in a section on optical rotatory power (p. 515) and does not appear in the index. The book is, however, the only one of its kind in the English language, and in view of its clarity and comprehensiveness (the index alone occupies 100 pages) it will be given an enthusiastic welcome by all who are seriously concerned with sugar chemistry.

R. J. McIlroy's "The Chemistry of the Polysaccharides" deals mainly with modern work on polysaccharides, a field in which new knowledge has been accumulating so rapidly that the author has been compelled to add an appendix giving advances which took place while the main body of the book was being printed. The accounts are clear and precise, with useful and adequate literature references. Their brevity is such, however, that they are likely to be of greater value to postgraduate students than to readers seeking some general knowledge of main achievements in polysaccharide chemistry. There is a most useful chapter on the methods of estimation of sugars, but it would have been more profitable to utilize the space devoted to "Derivatives of the Monosaccharides" for a more detailed description of the polysaccharides.

The third book on the list, J. Honeyman's "Chemistry of Carbohydrates", can be unreservedly recommended as an excellent introduction, on modern lines, to the structural chemistry of the sugars. It presents clearly the fundamental background of the subject, with the arguments set out in a way which renders the book specially valuable for undergraduate instruction and for readers who wish to obtain a general picture of this field. The scope is strictly confined to the structural chemistry of the sugars; but within this range the book contains a balanced account of the methods used in the investigation of both the simple and complex carbohydrates, with well-chosen examples to illustrate the results achieved.

E. L. Hirst

HINDU LIFE THROUGH THE AGES

Hindu Kinship

An Important Chapter in Hindu Social History. By Dr. K. M. Kapadia. Pp. xvi+320+xxxv. (Bombay: Popular Book Depot, 1947.) 15 rupees.

INDIAN sociology has for long been a subject of lively activity among anthropologists working in the field. Their activities have been devoted to the study of existing institutions, in all their variety, on the Indian sub-continent. Historical studies based on the study of literary documents, and so forth, have been pursued to a much less extent in this field. Yet it is important that such investigations should not be neglected, since these social organisms can only be fully understood in the light of their historical evolution and by the analysis of their diverse origin. Dr. K. M. Kapadia's book is therefore to be welcomed. It consists of a detailed and careful analysis of the data to be found in Sanskrit literature dealing with the family and its organisation. The author has decided to call his book "Hindu Kinship" rather than "Brahmin Kinship" because of the Brahmin habit of setting "the stamp of orthodoxy wholesale on many religious beliefs and social relationships that were alien to their own culture". Nevertheless, the subject-matter of the book corresponds more to a title "Brahmin Kinship". This is mainly what is dealt with in the law books and other literature which are analysed here. Practices outside the orthodox field are referred to casually, rather than systematically, and as exceptions to the norm rather than as constituents of different systems.

Beginning with the cult of the Manes, which is prominent from the earliest period, the author proceeds to the subjects of marriage, family organisation, adoption and affiliation, inheritance and succession, vicarious liabilities and debts, and birth and death impurities. All these are subjects which are exhaustively treated in Sanskrit law books and allied tracts. Dr. Kapadia's book is in a way more philological than sociological, in the sense that its main

pre-occupation is to find out what the texts really say. This is as it should be, since without a solid philological basis the material cannot be safely used for further work. It is also historical, so far as the chronology of the texts allows, and such changes as have occurred in the course of three thousand years are followed in detail. What is noteworthy is the small amount of change, at any rate in the orthodox interpretation, that has taken place in this period. The patriarchal pattern of family life which was introduced by the Aryan invaders remained in its essential principles unchanged throughout the history of Hinduism. The main course of development is an increasing strictness in the upholding of the various restrictions applied in this field, and to some extent an increase in their number.

Dr. Kapadia has provided for students of sociology a comprehensive and reliable account of this subject as it is found in the Hindu law books. Most of the essential material that is available is collected and presented here in a clear and systematic manner.

MATERIA COSMETICA

The Principles and Practice of Modern Cosmetics
By Ralph G. Harry. Vol. 2: Cosmetic Materials; their Origin, Characteristics, Uses and Dermatological Action. Pp. xi+479. (London: Leonard Hill, Ltd., 1948.) 35*s*.

MR. R. G. HARRY'S book passes under a sober English title, and perhaps the flamboyant Latinesque alternative could scarcely exist; yet it would have seemed almost permissible to invent it for a work as well-informed in scientific facts and as carefully responsible in its verdicts, as one could require in the treatment of the materia medica. The comparison is the more readily prompted by the pharmacopœial design of the book, in an alphabetical series of monographs, each subheaded with the synonyms, composition, provenance, properties, toilet uses and dermatological effects of its subject.

The author, indeed, refers specifically to the "diminishing gap between toilet manufacture and the preparation of remedial and healing skin creams", and deals judiciously with such medicinal constituents as penicillin, vitamins and hormones. A comprehensive and very readable monograph on "Herbals" reviews the claims of herbal ingredients, from early tradition down to recent findings on the bacteriostatic effects of chlorophyll and of plant juices from many different genera. Other topics in which the author carries the concept of 'cosmeticology' well beyond that of pure adornment are antiseptics, insecticides, insect repellents, sun-screening compounds and depilatories. Here, as elsewhere in the book, medical and dermatological findings are amply illustrated by references to original papers.

Space is also found for the treatment of such adjuncts to preparative manipulation as activated carbon for refinement of oils, fat-antioxidants and preservatives for finished products, and 'distilled water' prepared by adsorption. The greater part of the book, however, is naturally concerned with the basic materials of those creams and emulsions of which so many cosmetics largely or wholly consist. These include the following: most types of dispersing agents, for example, sulphated and sulphonated fatty bodies, quaternary ammonium salts, and soaps both organic and inorganic; dispersible fats and waxes such as those of the 'Lanette' type, wool-wax steroids and the 'mono-ester' class derived from fatty acids and polyhydric alcohols; the cellulose ethers and ether-esters, and alginates. It is hard to recall any previous treatment of the fatty group which supplies so much valuable matter in so concise a form. Thus, the thirteen pages devoted to fatty esters of polyhydric alcohols discuss in detail the manufacture and uses of the class, and give the usual 'fat constants' for twenty-seven American and twenty-eight British types—mono- and di-stearates (oleates, laurates, etc.) of glycerol, of ethylene and propylene glycols, and of mannitol and sorbitol.

It will be clear that the value of these sections is not only for the specialist in cosmetics. Most of the substances described have many other applications; one may cite the use of dispersible fats and emulsions in foodstuffs. The problem they present to the general analyst has so far been comparable to that which would be presented by the natural oils and fats if no accumulated data of iodine values and other 'fat constants' were available. That the two problems can be reduced to exactly the same footing is unlikely, if only because the caprices of manufacturers outnumber those of Nature herself; but Mr. Harry's contribution is a highly serviceable one, especially in that he has clearly enjoyed the confidence and co-operation of many leading manufacturers both in Great Britain and the United States.

One remains, indeed, a little uncertain as to how far the book has reference to British practice and how far to American. Pharmacopœial standards, which are given where relevant, refer to the "British Pharmacopœia". The standard specifications given for eleven generally used materials such as beeswax, borax and glycerin are those of the United States Toilet Goods Association. "British Industrial Methylated Spirit" is accorded a monograph, but except for a mention of denaturant use under "Diethyl Phthalate" there is no guidance on denaturing to British Excise requirements; yet sucrose octa-acetate has a monograph solely in virtue of its use as a denaturant, which is surely very infrequent in Great Britain. The use of the insect-repellent 'Indalone', which must be practically confined to the United States, is recorded, as is the similar application of dimethyl phthalate; but the discussion of diethyl phthalate omits its common British use in conjunction with the dimethyl compound; and dibutyl phthalate is not noticed. The colouring matters described are those 'certified' by the United States Food and Drugs Administration; this section has, however, a well-considered preface on the significance of the United States regulations and the desirability of similar British control.

This survey, though by no means fully exhibiting the scope of the book, will indicate the great variety of its matter and the amount of cross-reference involved in its most profitable use. For such use the simple alphabetical arrangement seems scarcely adequate, especially as there appears to be no consistent rule of titling the monographs either by commercial or by scientific names. Thus, 'Cellofas' (sodium carboxymethyl cellulose) figures under its trade name, while 'Collocel' (sodium cellulose glycollate) is under its chemical name. Other similar examples could be quoted. Though the book must already represent a most formidable labour of compilation, a detailed index would seem a merely just expenditure of tar for so gallant a ship.

E. G. KELLETT

The Theory of Solutions of High Polymers

By A. R. Miller. Pp. vii+118. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 12*s.* 6*d.* net.

THIS is a specialized monograph on a topic of great current interest. The thermodynamical behaviour of high-polymer solutions is of importance for many reasons. First, molecular size and shape can be determined if sufficient is known of the physical properties of the solution. Second, the intrinsic interest in the problem is a challenge to the theorist to get to grips with an exceptionally difficult problem. Even the proper understanding of the kinetic behaviour of high-polymer solutions is dependent on accurate knowledge of the system.

High-polymer solutions at all concentrations deviate so much from ideal behaviour that no slight extension of the theory of solutions is sufficient even to cover the case of very dilute solutions. Before the problem can be tackled statistically an acceptable model must be chosen. Dr. A. R. Miller therefore makes his choice and proceeds to develop the consequences, using all the laws of statistical thermodynamics. The first step is to calculate the free energy of mixing on the basis that the solution is athermal. Although there is not, unfortunately, a wealth of experimental data, the agreement between theory and experiment is surprisingly good, and demonstrates conclusively that the theoretical attack is along the right lines. When this simplification does not hold, matters are a good deal more complicated, and there are still discrepancies to be cleared up; but again the matter is put on a solid theoretical footing. More experimental work is needed to provide the basis for the construction of more accurate models suitable for statistical treatment.

H. W. MELVILLE

Flora of South Australia

(Handbook of the Flora and Fauna of South Australia, issued by the South Australian Branch of the British Science Guild, now incorporated with the British Association for the Advancement of Science.) Part 2: Casuarinaceæ–Euphorbiaceæ. By J. M. Black. Second edition. Pp. 253–521. (Adelaide: Government Printer, 1948.) 8*s.* 6*d.*

A SECOND edition of J. M. Black's well-known "Flora of South Australia" is in course of publication. The part recently received deals with the families of Dicotyledons from Casuarinaceæ to Euphorbiaceæ inclusive, essentially in the sequence of Engler and Gilg's "Syllabus der Pflanzenfamilien". Keys, descriptions and illustrations combine to make this a very practical flora. It is issued by the South Australian Branch of the British Science Guild (now incorporated with the British Association for the Advancement of Science.)

Families of particular interest include Casuarinaceæ, Proteaceæ, Chenopodiaceæ, Amarantaceæ, Aizoaceæ, Cruciferæ, Leguminosæ, Rutaceæ and Euphorbiaceæ. The species of Proteaceæ are less numerous than in some other States of the Commonwealth, and are represented by eight genera, of which *Hakea* with fifteen species and *Grevillea* with the same number are the largest genera. The Chenopodiaceæ, besides containing a considerable number of introduced weeds, are well represented in coastal and dry country habitats. *Bassia*, with 31 species, *Kochia* with 24, and *Atriplex* with 31 (of which three are introduced) are the largest genera. Many of the species of Cruciferæ are introductions, but there are a number of genera endemic to Australia, such as *Blennodia*, *Menkea* and *Phlegmatospermum*, while a few widely ranging genera, as *Lepidium*, have species limited to Australia. The largest family included in this part of the flora, the Leguminosæ, has many endemic genera and endemic species of more widely distributed genera. *Acacia*, with 89 species, is important taxonomically and ecologically in South Australia, and probably gave considerable trouble to key. *Pultenæa*, with 24 species, and *Swainsonia*, with 30, are other large genera. A large number of clovers and medicks have been introduced.

W. B. TURRILL

An Introduction to Organic Chemistry

By Prof. Ira D. Garard. Third edition. Pp. xi+396. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 21*s.* net.

THE author's aim is to give a concise rounded-off course of organic chemistry for students such as those of agriculture, home economics and medicine to whose main studies chemistry is ancillary. The contents comprise the simpler aliphatic and aromatic compounds usually described in an introductory course, together with a suitable scheme of practical work. Each chapter ends with a list of problems for study and a list of references.

By omitting matter requiring effort, such as the application of modern theories of valency to structure and reactions, and by stressing the economic uses of organic compounds, the author has made a most readable book. Thus we find him discoursing on proteins, rubber, nylon and dyes not only attractively but also in the light of modern knowledge. Prof. Garard handles his descriptive matter skilfully; his account of the paraffins includes the cyclic isomers, and his particularly well-written chapter on fats contains seven tables of information. His exposition of unusual terms such as 'azeotropy' and of new materials such as 'aerosols' is alike simple and adequate. For the above class of students this is a stimulating and interesting book.

G. F.

The Pharmaceutical Pocket-Book

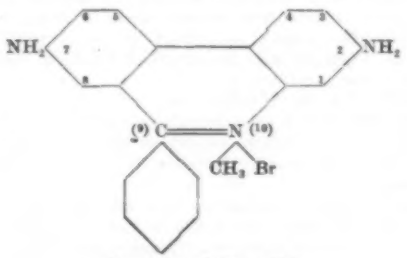
Fifteenth edition. Pp. x+430. (London: Pharmaceutical Press, 1948.) 12*s.* 6*d.*

"THE Pharmaceutical Pocket Book" has come to serve two purposes. It introduces students of pharmacy to the principles on which their profession is based, and it serves as a book of reference for the practising pharmacist. The new edition includes the many changes introduced by the new "British Pharmacopœia" which was published in 1948, and a summary of those provisions of the National Health Service Act which affect pharmacists. There are 20 pages devoted to biochemical analysis and 10 pages of notes on bacteriology. There is a dictionary of synonyms and trade names which occupies 77 pages. This is a formidable, but in some ways a disappointing, list. It is devoted mostly to archaic and picturesque synonyms which cannot be much used nowadays. It contains devil's dung, dragon's blood, doom bark, essence of smoke, hippo wine, little liver pills, madweed, mandrake and nihil album, but not benadryl or neoantergan, 'DOCA', 'BAL', mapharside, 'DFP', dolantin, demerol, priscol, paludrine or promin. The list would be more valuable if it was brought up to date. There should surely be, either here or somewhere else in the book, a guide to modern synthetic drugs. However, the book contains much information and will, no doubt, serve a useful purpose.

CHEMOTHERAPY OF *T. CONGOLENSE* INFECTIONS WITH PHENANTHRIDINE COMPOUNDS: BIOLOGICAL ASPECTS

By Prof. C. H. BROWNING, F.R.S.
Department of Bacteriology, University of Glasgow

IN the editorial article, "Sleeping Sickness and Nagana" (*Nature*, January 15), mention is made of phenanthridine compounds in the treatment of cattle infected with *T. congolense*. The following details are likely to be of interest for their theoretical bearing and also because more than two million doses of one of these drugs, 2 : 7-diamino-9-phenyl-10-methylphenanthridinium bromide (No. 1553 or 'dimidium bromide', see formula), have been administered to cattle in Africa, and very considerable outbreaks of trypanosomiasis have been controlled by its use (*The Times*, February 9).



Formula of No. 1553

Phenanthridine compounds synthesized by the late Sir Gilbert Morgan and Dr. L. P. Walls at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington, were examined by us for anti-infective properties (antiseptic[1], etc.), the work being supported by the Medical Research Council. *Inter alia*, it was found that 7-amino-9-*p*-aminophenyl-10-methylphenanthridinium chloride (No. 897) had definite chemotherapeutic action on experimental infection in mice both with *T. brucei* and *T. congolense*, although the effective dose approached the toxic limit[2].

In view of the refractoriness of *T. congolense* to most chemotherapeutic agents which act powerfully on *T. brucei*, and the serious economic effects of African cattle disease caused by the former, the work was continued. We then observed that a much smaller dose of compound No. 897 than originally stated was capable of sterilizing *T. congolense* infection[3]. On exploring this discrepancy, the knowledge gained enabled therapeutic experiments to be conducted under fairly uniform conditions. Also, for the first time apparently, a drug with powerful curative action on *T. congolense* was available. Accordingly, a study has been made of the responses of this parasite to chemotherapeutic agents, several strains being used[4,5].

It was discovered that *T. congolense* undergoes biological changes according to the duration of the infection, which markedly affect its therapeutic sensitiveness. In order to obtain consistent results, it is essential always to transfer the trypanosomes to a fresh mouse as soon as they become abundant in the blood, that is, at 'acme'. A strain so maintained is termed an 'acme strain'. After acme the parasites either may persist in the blood in large numbers for several days to many weeks, until the animal finally succumbs to the infection, or a relapsing course may be established, the number of trypanosomes in the blood fluctuating greatly from time to time and death occurring during an access. In general respects, the condition in mice resembles passably the natural disease in cattle. An occasional striking feature in heavy protracted infections in mice is stasis in the tail and ears, which become dark purple-red and undergo necrosis unless treatment is given.

When the infection becomes chronic (that is, when the animal lives for more than several days after acme), a larger dose of the drug is required for sterilization than suffices at acme. Further, this diminished therapeutic response is shown also in fresh animals inoculated with such a 'chronic variant' strain. It is noteworthy with the acme strain that when treatment is administered at an early stage of infection, before parasites have become abundant in the blood, a larger dose of the drug is required to effect cure than at acme. This contrasts with *T. brucei* infections in mice and suggests that the immunity reaction following destruction *in vivo* of *T. congolense* plays a very significant part in bringing about sterilization—at least through the agency of phenanthridine drugs. The trypanosomes derived from a chronic infection have also the characters of a 'relapse strain', that is to say, an animal sterilized of an infection with the acme strain, while immune to re-inoculation with the same strain, becomes infected on re-inoculation from a chronically infected mouse. This relapse character may persist for a considerable time when such a chronic variant strain is subjected to a series of passages. Eventually, however, the original acme character seems to become re-established. (Our various acme strains were obtained by prolonged acme-passage through mice until the infection became accommodated.) The relapse strains of *T. congolense* showed a remarkable difference from those of *T. brucei* originally described by Ehrlich. A mouse cured of infection with a relapse strain of the latter is susceptible to the original strain; but this is not the case with *T. congolense*. However, later work has shown that this feature is not exhibited by all acme strains of the parasite; for example, animals cured of infection with a chronic variant of the 'Busimbi' strain are not immune to re-inoculation with the corresponding acme strain[4].

Of the series of phenanthridine compounds prepared by Dr. Walls[7] the most effective against *T. congolense* is No. 1553 (*vide supra*)[5,8]—with mice the ratio of the maximum tolerated dose to the minimum curative dose (more than 50 per cent cured), injected subcutaneously at acme, being 400 : 1 to 40 : 1 according to the strain. With No. 897 the ratio is 100 : 1 to 10 : 1; the less favourable results of Fulton and Yorke[9] may be explained by the early stage at which treatment was carried out[5]. We have not yet compared 'Antrycide' under similar conditions; but no other substance so far known approaches No. 1553 in efficacy (see also Wien[10]). In infected cattle the

superiority of No. 1553 over No. 897 was also manifest. Of course, in cattle the 'therapeutic index' is much lower[8]; but a single dose of No. 1553 at the rate of 1·5–2·0 mgm. per kilo of body-weight injected into the tissues or intravenously is usually well borne and appears to be the standard curative dose (Carmichael and Bell[11]). Neither No. 897 nor No. 1553 protects normal mice for longer than a few days (less than four or five) when a large dose is injected subcutaneously and the animals are afterwards inoculated. Prophylactic action in cattle for two to four weeks has been reported, however (Crawshaw[12], Stewart[13]).

The occasional occurrence in cattle, some weeks after treatment, of toxic symptoms resembling photosensitization (Bell[14]) has been an undesirable complication of therapy with phenanthridine No. 1553. The precise conditions determining the development of those effects have not been defined. Similar phenomena have been recorded apart from treatment, and nothing comparable has been produced in small rodents (Brownlee *et al.*[15]). Where cure fails to occur in cattle, the relapses seem generally to be less amenable to further dosage with phenanthridine drugs. This soon emerged with No. 897, and has been attributed to the rapid acquisition of drug-resistance by the trypanosomes. But our persistent attempts to produce drug-fast strains in mice by the various known methods have failed; for example, where repeated relapses were on each occasion treated with a single injection of a dose curative for less than 40 per cent of original infections at acme, sterilization was effected ultimately in the same proportion, cure resulting even after the twentieth relapse[4,5]. The diminished therapeutic response in relapsed cattle seems similar to our observations with chronic strains in mice. By analogy, it is possible that drug-fastness of the trypanosomes may develop more readily in one species of host than in another. But the problem as regards cattle requires more extensive investigation than it seems to have received so far.

On comparing acme strains derived originally from different natural sources, marked differences were found in virulence, susceptibility to the chemotherapeutic drug and 'solidity' of immunity to re-inoculation with the homologous strain following cure[4,5,9]. As regards immunity, with one strain animals were refractory to a single massive re-inoculation more than a year after cure, or to repeated re-inoculations over this period. This suggests a method of protecting herds by artificial inoculation followed by treatment. On the other hand, with another strain only 50 per cent of animals resisted re-inoculation even after recent cure; and of these again, 50 per cent became infected after a second re-inoculation and so on. Little or no cross-immunity exists between different acme strains. Those differences have persisted without noteworthy change during many years of 'syringe-passage'. It remains to be determined whether in their natural habitat strains from cattle in one locality show considerable uniformity, or whether a variety of strains with distinct characters exist side by side in the same place.

T. vivax infection (in cattle) also responds to the phenanthridine compounds which are effective against *T. congolense*; but no member of the series is very potent toward *T. brucei*. *T. cruzi* infection in mice (one strain tested) is influenced by certain members[16], especially 3-carbethoxyamino-9-*p*-carbethoxyaminophenyl-10-methylphenanthridinium chloride (or methanesulphonate) and also 2 : 7-dicarbethoxyamino-9 : 10-dimethylphenanthridinium methosulphate, neither of which acts on *T. congolense* or *T. brucei* except in maximal doses.

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METEOROLOGY IN AGRICULTURE

THE ordinary meeting of the Royal Meteorological Society on March 16 took the form of a discussion of weather problems in farming, three speakers presenting prepared papers. As these papers could not be circulated in advance, they had to be read in full, so that general discussion was restricted in time, and would have been even more so if one of the three had not been self-sacrificing by confining himself to a few comments.

Opening the meeting, Dr. H. L. Penman directed attention to three kinds of problem: statistical, biological and physical. Statistical problems include, among others, the forecasting of both weather and crop yields. Of the former, he said that when they could be obtained, long-range forecasts would be of immense value; but even the scope of present-day forecasting technique could be made more useful to farmers, and this point was emphasized in the later discussion by Dr. J. Meiklejohn, who urged the establishment of a regional forecast service designed in language and scope for the particular needs of farmers and not exclusively for the benefit of agricultural scientists. Dr. Penman stated that attempts to forecast crop yields from weather data had a long history of failure, a failure due to neglect of the biological side of the problem; but in spite of his plea that future activity of this kind should start with biological measurements, Prof. Dudley Stamp asked that more meteorological measurements should be taken to help land utilization experts and town planners to do their job less harmfully to farming interests. Another contributor to the discussion, Mr. A. W. Ireland, from the Sudan, pointed out that yields of irrigated cotton can be predicted with considerable certainty merely from a knowledge of rainfall before sowing.

Biological problems, Dr. Penman continued, involve quantitative study of the growth, spread and decay of biological activity and their dependence on weather, and present a wide field for research in general and local meteorology and in micro-meteor-

ology, in which the objective must be to answer some particular biological question. Some of these problems present a challenge to meteorological physicists on their own ground, for turbulent transport of spores and pollen involves the same ideas as turbulent transport of heat and water vapour, but are at least one degree more difficult because the suspended material has a terminal velocity of settling too big to be neglected in the analysis. Physical problems of importance in farming include not only the analysis of this turbulent diffusion, but also study of the heat balance of the earth—always of importance, but particularly so in investigating early summer radiation frosts—and of the water balance, since water is indispensable in any system of farming.

As an illustration of the application of fundamental physical research to practical farming, Dr. Penman then outlined work recently done at Rothamsted on the relation between weather and water consumption by crops. Because of the large latent heat of vaporization of water, much of the incoming energy from the sun is used up in evaporating water—if the water is there to be evaporated—and by measuring or estimating other components of lesser importance it is possible to draw up an energy balance-sheet in which the only unknown is evaporation. This theoretical work can be employed in practice to estimate the transpiration-rate from a fresh green crop with an adequate water supply, given measurements of wind speed, air temperature, dew-point temperature and duration of bright sunshine. The condition of 'adequate water supply' being the condition aimed at in any good irrigation system, the treatment is directly applicable to irrigation control. To demonstrate this, he described an experiment on irrigation of sugar beet on a Surrey market garden during 1948 in which one of the irrigation treatments was controlled on the basis of data returned weekly from a small weather station set up on the experimental field. In the course of the summer, irrigation was called for three times (total applied, 2·6 in.), but in all cases subsequent rainy periods rendered these irrigations superfluous, or almost so. In addition to unirrigated control plots, a third set was irrigated at the farmer's discretion (five times; total applied 4·7 in.), but because natural rainfall was estimated to have been entirely adequate, no major differences in yield were expected. Nor were they obtained, though there was a slight, non-significant bias in favour of the plots that had restricted irrigation. Soil samplings before and during the cropping confirmed the weather-based estimates of the amount of moisture removed by the crop.

Dr. L. Broadbent then gave a survey of the weather problems encountered by biologists, with particular reference to the potato. His main concern was the intervention of weather in attempts to produce full yields of healthy potatoes; but he commented also on problems of storage in clamps and the degree of thermal and physical insulation that must be provided to prevent too rapid heat loss in cold, moderately calm weather and to prevent penetration of cold air in windy weather. Logically, it can be interpolated here that Mr. R. W. Gloyne also made a brief reference to deterioration of 'seed' potatoes during transit from Scotland to southern England, and the problem of determining night radiation losses of heat from the railway trucks in which the potatoes are carried.

The need for this annual transfer of seed took up the greater part of the remainder of Dr. Broadbent's paper. Because of the weather conditions in the seed-raising areas and the general absence of winter host plants for the insect vector, the seed from Scotland arrives almost, if not completely, free from virus disease. Odd tubers, however, might have such a disease, and potatoes left in the ground from an earlier crop might have it, so that invariably all English potato crops carry a few nuclei of infection. The infection is spread by the aphid, *Myzus persicæ*, and Dr. Broadbent gave an interesting account of his experiments to determine those micro-meteorological conditions within the potato crop that would lead to insect movement from plant to plant, or inhibit it; since the insect carries the disease with it, the study of spread of the disease is, in fact, largely the study of the movement of the insect. He first showed the inadequacy of Stevenson screen temperatures as guides to what is happening inside the crop, and although in the later discussion there were some good-natured sallies against such screen readings, the chairman, Mr. E. Gold, clearly expressed the feeling of the meeting in stating that while for general synoptic surveys the standard screen is adequate, for particular problems data would have to be collected in other ways. To this Mr. W. H. Hogg added the comment that night minima in the screen seem to be reasonably representative of those measured in Dutch lights at ground-level.

Dr. Broadbent also gave an account of work, largely exploratory and still in the pioneering stage, aimed at measuring temperature and humidity gradients, and the degree of air movement, inside potato crops of different spacings and vigour. The aphid will not fly if the air-speed around it is more than 3–4 m.p.h.; but even the early results show conclusively that flying conditions may often be suitable inside the crop when they are unsuitable outside, so that a chance eddy, or an imprudent excursion, may take the insect out into the faster-moving air to be swept uncontrollably along to another part of the same field, to another field, or even to another county—carrying infection with it if it was previously feeding on an infected plant.

It was unfortunate that Mr. R. W. Gloyne, of the newly formed Agricultural Branch of the Meteorological Office, had to compress his remarks, but even so he gave a fascinating glimpse of his activities as meteorological attaché to the south-west province of the National Agricultural Advisory Service in Britain. He, too, was concerned with potatoes, not only with the transit of seed and storage of tubers but also with the possibility of issuing special weather forecasts of the imminence of the hot humid conditions that lead to rapid multiplication of the spores of potato blight, one of the few diseases that has a clearly marked and fairly well-known association with a particular type of weather. Of special forecasts in general, he, like a later contributor to the discussion, pointed out that farming has to go on whatever the forecast, and that we must be careful not to over-estimate the value of farmers' weather forecasts, particularly for men working on a small scale. For large units, however, such forecasts might realize their expected value.

The scale of farming activity and its dependence on weather appeared also in another of his topics, which he referred to as "farming climatology". Many harvesting operations, of which haymaking is an outstanding example, can only be successfully carried out if there is a certain weather sequence, usually of days without rain, at the time of the operation; the amount of crop that can be successfully harvested is

limited by the length of this suitable period, by the labour and equipment available for the job, and by the technique used for the operation. For a given size of farm with normal staff and equipment, the optimum area of crop will be limited by the probability of getting the necessary weather sequence and by the harvesting technique. For hay, eastern England can count on a long sequence of good haymaking days, so the technique used there may not be equally successful in the south-west with its higher and more frequent rainfall; the most effective technique for the south-west would be one making some allowance for the climate of the region.

A further general topic led Mr. Gloyne to a point of particular interest. As is well known, dusting and spraying techniques against insect attack and plant pathogens are, like the spreading of some fertilizers, at the mercy of the wind. The wind-speed above which control becomes very difficult varies with particle-size and spreading technique; but it is usually a long way below gale force, and for finer materials may be only a few miles an hour. When the material is suspended or dissolved in water, high-pressure spraying is usually successful; but there are areas so short of water that it must be applied as a dust, and the problem arises of finding some means of making the dust stick to the plants. A heavy dew deposit will serve, and Mr. Gloyne had been asked if it would be possible to get forecasts of occasions on which early mornings of heavy dew would be followed by conditions calm enough for dusting operations to be carried out without undue loss by blowing away.

Mr. Gloyne's final remarks would be broadly accepted by most present: meteorology should be more concerned with growing food and less with getting an aeroplane from place *A* to place *B*; and an early resumption of the discussion was highly desirable. H. L. P.

NUTRITION AND FERTILITY

THE War accentuated the difficulties of food production and the maintenance of an adequate diet for human use. Actual destruction and the diversion of human activity to destructive aims, mass movements of the population to avoid or assist military operations, and the natural increase of the population, which in spite of these disturbances continued with very little check, have brought peace-time problems of great urgency: how to maintain or raise the standard of nutrition, and at the same time make provision for the increasing population or alternatively how to control the rate of increase. Nutrition and fertility are therefore socially and economically related as well as causally connected. The emphasis of the Conference held by the Nutrition Society on March 5 was on the causal connexions, but many experiences were drawn from the social and economic spheres. Thus, Dr. G. I. M. Swyer directed attention to the apparent paradox that in the East (China, India, etc.) a high birth-rate and expanding population is associated with poverty and under-nourishment, whereas in the West adequate nourishment is associated with a stationary or declining population. Prof. A. St. G. Huggett, on the other hand, instanced the effects of starvation or near starvation on the depression of the conceptual-rate, birth-rate and birth-weight, and increase in abortion-rate and prematurity-rate, in the populations of Stalingrad and Holland during the worst periods of the War. Dr. J. Edwards showed that data collected from animal artificial insemination centres primarily concerned with increasing the milk production could be analysed to give valuable information on the effect of seasonal nutrition on bovine fertility. Dr. J. Hammond and Dr. S. J. Folley both drew inferences on the effects of nutrition on fertility from agricultural practice, and Prof. Huggett and Dr. Swyer from clinical medicine.

This approach to the subject from a wide field of generalizations necessarily brought to light the existing lack of exact knowledge on many subjects, which was particularly evident in the case of nutritional therapy. The Conference succeeded, however, not only in directing attention to gaps in our knowledge but also summarized much original and recent research.

Dr. J. Hammond, in his paper on "The Physiology of Reproduction in Relation to Nutrition", gave a very broad review. The onset of puberty is determined by factors outside the gonads; immature ovaries implanted into adult animals function immediately; mature ovaries implanted into immature animals do not function until puberty is reached. The activity of the gonad and body-growth are determined by the hormones of the anterior pituitary, and normally the onset of puberty occurs as the adult growth-rate diminishes, so that the onset of puberty must depend upon a balance of output between the growth hormone and the gonadotrophic hormones. A very high plane of nutrition may reduce the time of onset of puberty, but the weight of the animal at puberty is increased. In the mammal this may be a disadvantage by causing a diversion of nutrients from the embryo and mammary gland to the body tissues. Conversely, poor nutrition leads to delay in the age of puberty, but puberty occurs at a lower body-weight than normal. In this case pregnancy and lactation place a considerable burden on the undergrown mother. Good nutrition increases the number of ova shed. The number of ova fertilized may depend upon the viability of the spermatozoa, and there is some evidence that this is affected by the nutritional condition of the male. Development of the sheep embryo during gestation is affected by the plane of nutrition. The birth-weight and viability of lambs born to ewes underfed during the later stages of pregnancy may be seriously affected and subsequent growth retarded by deficient lactation.

Dr. A. Walton, speaking on "Spermatogenesis and Nutrition", gave an estimate of seminal output in the male and showed how this is related to the total metabolic activity of the testes. The total weekly output of semen even during great sexual activity is extremely small and cannot be regarded as a serious drain on the nutritional requirements. The spermatozoon is a highly differentiated cell in some respects, but genetic argument leads to the conclusion that the nucleus contains half the genes which are common to the somatic cells. The locomotory apparatus and metabolism are similar in most respects to muscle.

Dr. J. Edwards, on "Variations in Fertility Levels in Bovines", analysed data from insemination centres to show that although cows are fed very differently during winter and summer, the conception-rate is not significantly affected. Contrary to common expectation, the lowest rate is found to be in the quarter of the year from April to June. Bulls show no striking effects of nutrition on semen output. Dr.

S. J. Folley, on "Nutrition and Female Fertility", dealt more specifically with the causal mechanisms of nutrition. Since reproductive activity is largely controlled through endocrine mechanisms, it is to be expected that nutritional effects will act through the endocrine glands. Evidence that anterior pituitary activity is affected by nutritional factors is available. For example, rats on a restrictive diet show no œstrous cycles, but respond to injections of gonadotrophic hormones. Atrophied accessory sex organs of rats on a diet deficient in B vitamins may be restored by injection of gonadotrophic hormones. Lowered pituitary function due to inadequate nutrition may be the cause of anœstrus during winter in heifers. A direct effect of nutrition on the ovary is not established, but since the œstrogen-level in the body is due to the balance between production by the ovary and excretion, deficiencies in the excretory mechanism may lead to syndromes similar to those set up by excess œstrogen activity in the ovary. B-deficiency (thiamin and riboflavin) and diets low in lipotrophic factors may affect the efficiency of the liver to inactivate œstrogens and lead to syndromes relating to sterility, such as pathological uterine bleeding. Evidence that nutritional factors may affect the responsiveness of the tract to œstrogens is provided by Herz, who found that the oviduct of chicks fed on diets deficient in folic acid did not respond to œstrogens; 20 μgm. of folic acid daily restored normal responsiveness. Some analogous results have been found in mammals.

Prof. A. St. G. Huggett, on "Nutrition and Viable Young", dealt in detail with a more limited aspect of nutritional deficiency, namely, the placental life of the embryo. Vitamin A deficiency results in a generalized metaplasia of epithelial surfaces. In the rat there is continuous keratinization of the vagina. Usually the fœtus goes to term but dies because the birth mechanism is upset. In severe cases, however, placental death and fœtal absorption may occur. Vitamin E deficiency has no action on rats before the eighth day from copulation, that is, three days after implantation. There are parallels between the action of E deficiency and experimental embryonic trauma. In both cases changes in the placenta result from destruction of the mesoderm tissues and allantoic blood flow. The fœtus is resorbed, but the trophoblastic placenta stays in position and is delivered at term. Apparently vitamin A deficiency kills the fœtus as a secondary effect of placental death, whereas vitamin E deficiency acts mainly on fœtal hæmatopoietic organs and leaves the decidua and trophoblast intact. Riboflavin deficiency in rats may result in many congenital deformities, but this effect only occurs during the early stages of pregnancy when apparently riboflavin is essential to early ossification. An interesting parallel occurs with rubella infection, which may result in congenital cataract or heart lesions if the mother is infected in the second month of pregnancy.

Dr. G. I. M. Swyer, who discussed "Nutrition and Human Fertility", was concerned mainly with clinical diagnosis and therapy. Gross under-nourishment results in amenorrhœa and menstrual disorders and a fall in conception-rate. Over-nourishment and obesity are commonly associated with infertility in women. Recent observations by Barton and Wiesner on refractory cervical block, which is common in sterile obese women, show that the condition responds with marked success to a dietary free from sugar. The precise way in which dietary sugar brings about the syndrome of obesity, genital infection and refractoriness to œstrogens is still obscure. Successful treatment of infertility with vitamin E has been much advertised. For the male the evidence is mostly negative or statistically inconclusive. For women there is evidence that habitual abortion may be successfully treated with vitamin E.

ARTHUR WALTON

OBITUARIES

Dr. A. Cunningham

BY the death of Dr. Andrew Cunningham in Edinburgh on March 4, agricultural bacteriology has lost an outstanding figure. The son of a farmer, Cunningham was born near Glenfarg on August 26, 1890. From school at Perth Academy he proceeded in 1908 to the University of Edinburgh, and after graduating in agriculture in 1911 he worked for a year in the chemistry department of the Edinburgh College of Agriculture. Deciding to study bacteriology, he spent the following winter at the Lister Institute and King's College in London, and then proceeded to Leipzig, where he worked for a year under Felix Löhnis. There, his first investigation concerned plate counts of bacteria in soil and milk, and he showed the importance of long incubation at a low temperature if maximum counts are to be obtained. In Leipzig, also, he did some of the pioneer work on the Protozoa of soil and their influence on the soil microflora. Cunningham's future career seems to have been greatly influenced by Löhnis, and it may be more than coincidence that the two men bore a remarkably strong resemblance in temperament and scientific outlook.

After working for short periods at Berne, Shinfield and Rothamsted, Cunningham joined the army in 1915 and saw active service in France. On demobilization in 1919 he was appointed lecturer in bacteriology at the Edinburgh College of Agriculture. With characteristic energy he overcame the many difficulties of building up from virtually nothing an efficient teaching department. Six years later he exchanged the lectureship for the post of adviser in bacteriology, and he at once entered with enthusiasm into the work that continued until his death. In addition to his advisory duties, Cunningham was able for several years to devote much of his time to purely scientific work on the anaerobes of soil and manures. He found that some of the butyric acid bacilli displayed a life-cycle similar to that described in *Azotobacter* by Löhnis and Smith. This work, although its findings are still controversial, ranks as the most important in his career, and it provided material for the thesis accepted by the University of Edinburgh for the degree of D.Sc. in 1931.

Cunningham's published work covers a considerable range of agricultural subjects, including the bacteriology of silage and manures, methods of examining milk, taints in milk, and the inoculation of lucerne. In recent years he had been occupied principally in an investigation of bovine mastitis, where one may easily detect his carefully devised plans, which were carried out with determination and meticulous care. His "Practical Bacteriology for Students of Agriculture", which is now in its third edition, is widely recognized as one of the best books of its kind. Abstract journals appreciated his services

as a writer of concise but informative and critical abstracts.

Cunningham will be remembered as a man with a forceful personality who frequently gave expression to his strongly held opinions and acute judgments. These qualities were combined with an exceptionally wide knowledge of bacteriology. He was invariably interesting and helpful as a contributor to scientific discussions, and he was a most useful member of committees. His health had been progressively deteriorating for some time before his death. He is survived by his wife, whom he married in 1921.

T. GIBSON

WE regret to announce the following deaths:

Dr. Sydney H. Ball, mining consultant to the U.S. War Production Board, known for his work on the geology of the United States and of the Belgian Congo, on April 10, aged seventy-one.

Prof. Jules Drach, member of the Section of Mechanics of the Paris Academy of Sciences, professor of analytical mechanics at the Sorbonne, on March 7, aged seventy-seven.

Dr. A. D. Imms, F.R.S., lately reader in entomology in the University of Cambridge, on April 3, aged sixty-eight.

NEWS and VIEWS

National Chemical Laboratory of India: Prof. J. W. McBain, F.R.S.

IT is announced that Prof. J. W. McBain, who has recently retired from the chair of physical chemistry at Leland Stanford University, California, has been appointed the first director of the National Chemical Laboratory of India. It is difficult to think of a better choice. While his many English friends have not seen so much of him since he left the University of Bristol, yet they have been able to follow his steady development of the concept of the micellar structure of colloidal electrolytes, a chapter in physical chemistry which is particularly his own. The number of papers which have emerged from Bristol and Stanford is indeed prodigious, and the world is richer for the numerous students whom he has trained. Not only are we indebted to McBain for a great extension of our knowledge of the colligative properties of these solutions, as well as conductivity and surface action, but also the behaviour of such colloidal solutions in respect to the interesting properties of emulsions and emulsion polymerization, solubilization and the like, have been fully explored by him. While his main interest has lain in this field, we must recollect that we are also indebted to him for coining the word 'sorption', thus directing attention to the complexity of the interactions between a gas and a solid, and that his treatment of the subject of adhesion in the British Association Reports still remains a classic. His many friends and colleagues will wish him well in this new and important venture.

Royal Geographical Society: Awards for 1949

HIS MAJESTY THE KING has approved the award of the Royal Medals of the Royal Geographical Society as follows: *Founder's Medal*: Prof. L. Dudley Stamp, professor of geography, London School of Economics, for his work in organising and directing the Land Utilization Survey of Great Britain and his application of geography to national planning; *Patron's Medal*: Prof. Hans Pettersson, professor of oceanography at Göteborg Hogskola, Sweden, for his leadership of the recent oceanographical cruise in the *Albatross*, in the course of which much new evidence has been obtained as to the geology of the ocean floor. The Council of the Society has made the following awards: *Murchison Grant*: Lieut.-Colonel E. H. Thompson, for original researches in the techniques of air survey, and for the development of stereoplotting machines; *Back Grant*: Dr. Brian Roberts, research fellow of the Scott Polar Research Institute, for his contributions to polar history and to the technique of polar travel; *Cuthbert Peek Grant*: Mr. A. B. Crawford, for surveys and meteorological work carried out by him at Tristan da Cunha and Marion Island; *Gill Memorial*: Dr. O. H. K. Spate, reader in geography at the London School of Economics, for his work on the geography of India and Burma.

Scientific Liaison Officer in France: Mr. A. H. Waterfield

IN agreement with the Foreign Office, the Department of Scientific and Industrial Research has appointed Mr. A. H. Waterfield, a principal scientific officer, formerly of the Ministry of Supply, for scientific liaison duties in France, with the rank of attaché at the British Embassy in Paris. Mr. Waterfield, who is a metallurgist with special experience in the light-alloy field, was formerly on the headquarters staff of the Ministry of Aircraft Production, later the Ministry of Supply, and during the past year has been secretary of the Inter-Service Metallurgical Research Council. During 1946–47 he was attached to the United Kingdom Scientific Mission in Washington for metallurgical liaison duties.

Royal Observatory, Greenwich: Transfer to Hurstmonceux

IN the House of Commons on March 25, Mr. Hollis raised certain important points about the conditions prevailing at Hurstmonceux and also regarding the delay in assembling the instruments and in providing adequate accommodation for the staff. Mr. Hollis dealt with a number of matters that have already been emphasized by the Astronomer Royal in the Report for 1948 to the Board of Visitors and repeated by the Chief Assistant elsewhere. Mr. Hollis urged that the work at Hurstmonceux should be given an extremely high priority and pushed forward with all dispatch. The cost of the building necessary to put the new Observatory into full commission amounts to about half a million pounds, and, while admitting that such an amount cannot be treated lightly, it was pointed out that the prestige of Great Britain has been highly valued on account of the position of the meridian of Greenwich, and that there are "few matters on which such a sum could be better spent". In addition to scientific issues, Mr. Hollis raised another point—the artistic problem of Hurstmonceux. The south side of the castle presents an unsightly spectacle with a number of temporary huts of brick

and wood, and although they were not placed there by the Admiralty, it was suggested that the Admiralty should remove them. Further, when permanent buildings take their place, these should be screened from the castle. He asked for a guarantee from the Civil Lord of the Admiralty that the Royal Fine Art Commission should be consulted in the matter, and made some suggestions regarding the site of these new buildings.

Mr. Hollis was strongly supported by Major Tufton Beamish, who asked for full assurances that the local authorities should be consulted in the scheme, in which they are deeply interested. The Admiralty would receive the full co-operation and all possible help from the local bodies concerned in the transfer of the Royal Observatory to Hurstmonceux. Mr. Walter Edwards, Civil Lord to the Admiralty, gave certain assurances, and stated that the Admiralty would take the Royal Fine Art Commission fully into its confidence before the second or third stage is undertaken, and also that he was prepared to consider the question of taking the local authorities completely into consultation. He thought that the Observatory would be in a proper state, counting the war period, in a little less than fifteen years, which, presumably, implies about five years from the present time. It is the fervent hope of all who are interested in scientific progress in Great Britain that this expectation will be fulfilled.

Oscar Hertwig (1849–1922)

One of the founders of the science of heredity and one of Germany's most brilliant embryologists and comparative anatomists, Wilhelm August Oscar Hertwig was born a century ago, on April 21, 1849, in Friedberg, Hessen. A pupil of Schultze, Haeckel and Gegenbaur, he graduated at Bonn in 1872, and in 1881 became professor of anatomy in Jena. Seven years later he was appointed to the chair of general anatomy and embryology at Berlin and to the directorship of the newly created Anatomical–Biological Institute. He served as rector of the University during 1904–5. Retiring in 1921, he died on October 25 of the following year, aged seventy-four. A voluminous and authoritative writer, his works (some in collaboration with his brother Richard) went through many editions and were translated into several languages, for example, his "Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere". "Die Zelle und die Gewebe" (1893) in the second edition (1906) changed its title to "Allgemeine Biologie", for the author believed that the problems of the living body could be reduced to problems of the single cell. Hertwig was one of the first to teach that the physical basis of heredity must be sought in the chromosomes. His "Cölomtheorie" (1881) helped to complete Balfour's theory of the germinal layers. Perhaps his most important achievements were his discovery in 1875 of the process of fertilization in the sea-urchin, and his observation in 1890 of the first case of parthenogenesis in the animal kingdom—in a starfish. For a number of years he edited the *Archiv für Mikroskopische Anatomie*. It is a curious fact that the disciple of Haeckel and Gegenbaur in the end apostatized from Darwinism.

Industrial Gas Turbine Development Committee

The Minister of Supply, anxious that all possible steps are taken to ensure that Great Britain exploits to the full the industrial applications of the gas turbine, has set up a Committee to keep this matter under continuous review and to make recommendations to him as to any further research or development work which the Committee thinks should be put in hand. Sir William Stanier is chairman of the Committee, which will also include, in addition to experts from interested Government departments, a number of independent members well known in combustion engineering circles. The composition of the Committee is as follows: Sir William Stanier (chief mechanical engineer, London Midland Region, British Railways); Sir Frank Whittle (adviser on operation and development of gas turbine aircraft to B.O.A.C.); Prof. O. A. Saunders (professor of mechanical engineering, Imperial College of Science and Technology); Sir Henry L. Guy (secretary, Institution of Mechanical Engineers); Rear-Admiral (*E*) D. J. Hoare (director of research, British Internal Combustion Engine Research Association); Dr. T. W. F. Brown (director of research, Parsons and Marine Engineering Turbine Research and Development Association); F. Shakeshaft (British Electricity Authority); Dr. D. T. A. Townend (National Coal Board); A. A. M. Durrant (British Transport Commission); Dr. F. M. Birks (British Gas Council); Sir Archibald J. Gill (General Post Office); Dr. H. Roxbee Cox (Ministry of Fuel and Power); Dr. G. A. Hankins (Department of Scientific and Industrial Research); Dr. A. Parker (Department of Scientific and Industrial Research); A. E. N. Taylor (Ministry of Transport); Sir Denys C. Ford and Dr. J. A. Carroll (Admiralty); J. Anderson and A. E. MacColl (Scottish Home Department); Capt. (*E*) M. Luby, H. Constant, Lieut.-Colonel P. E. Holmes and A. P. Wickens (Ministry of Supply).

Skipton Earthquake of 1944

Dr. H. C. Versey has collected macroseismic data concerning the Skipton earthquake of December 30, 1944 (*Trans. Leeds Geol. Assoc.*, 6, No. 2; 1948), which shows that the earthquake had an intensity 7 on the Davison scale at the centre of greatest disturbance near the Gargrave Fault. In the central area subsurface drains were broken, and damage was caused to a bridge. York was just within isoseismal 5, and Lincoln, Manchester and Carlisle were within isoseismal 4. Dr. Versey relates the centre of disturbance to the Craven Faults near the margin of the rigid block of north-west Yorkshire with its early Palæozoic and possibly pre-Cambrian basement rocks. Previous shocks at Kendal (March 17, 1871), Wetherby and York may also have been connected with the faulted boundaries of this rigid block. Sound phenomena associated with the Skipton earthquake were heard by various observers, particularly those situated inside isoseismal 6, who compared the sounds with the rumbling of vehicles or the rushing of a strong wind.

University of Edinburgh

The trustees of the Godfrey Thomson Research Fund have given £5,000 to the University of Edinburgh, and promised an annual payment of £1,000 (in the first instance up to 1952) to permit the establishment of a readership in educational research, the holder of which will be largely concerned with research into problems of testing and selection. The Godfrey Thomson Research Fund draws its income from royalties on the Moray House Tests, of which the fiftieth was recently completed, and on fees from county and city education authorities for the use of

tests and for statistical advice. The five trustees of the Fund, which is devoted to educational research of all kinds, but especially the improvement of intelligence and aptitude tests, are appointed by the University of Edinburgh.

University of London

THE title of reader in the University of London has been conferred on the following in respect of the posts mentioned: Dr. Moses Blackman (theoretical physics, Imperial College of Science and Technology); Dr. J. McG. Bruckshaw (geophysics, Imperial College of Science and Technology); Dr. S. H. Harper (organic chemistry, King's College).

Mr. Eugene Grebenik has been appointed to the University readership in demography tenable at the London School of Economics and Political Science as from October 1, 1949.

The degree of D.Sc. has been conferred on Mr. Allan Walkley (Rothamsted Experimental Station) and Mr. F. R. Selbie (reader in bacteriology, Middlesex Hospital Medical School).

University of Glasgow

THE following appointments have been made: Dr. A. M. MacDonald (from Edinburgh) to be Gardiner lecturer in pathology of diseases of infancy and childhood; Drs. R. A. Raphael (Imperial College, I.C.I. Fellow), D. S. Payne (Imperial College) and Mr. G. L. Buchanan (University of Aberdeen) to be lecturers in chemistry; R. C. Curran (Stobhill Hospital) to be lecturer in pathology at the Royal Infirmary; C. A. Hopkins (Trinity College, Dublin) to be lecturer in zoology for veterinary students; Miss A. E. Nicolson, J. S. MacPherson and R. B. Walker to be assistants in mathematics; and Dr. C. M. McLean to be an assistant in ophthalmology. Dr. G. M. Badger is resigning his I.C.I. Fellowship to become senior lecturer in organic chemistry in the University of Adelaide.

Fourth International Gas Conference

THE fourth International Gas Conference of the International Gas Union will be held, under the presidency of Colonel C. M. Croft, at the Institution of Civil Engineers, Great George Street, London, S.W.1, during June 15–17. During the mornings, papers will be read, followed by discussion, dealing with many aspects of the gas industry in Great Britain, the Continent of Europe and the United States. The afternoons will be devoted to excursions to gas works and associated industries and also to places of cultural interest. Full particulars may be obtained from the Secretary of the Institution of Gas Engineers, 1 Grosvenor Place, London, S.W.1. The annual general meeting of the Institution of Gas Engineers will precede the Conference, taking place during June 13–14.

Royal Photographic Society: Officers for 1949

AT the annual general meeting of the Royal Photographic Society held on March 22 the following officers were elected: *President*, Percy W. Harris; *Vice-presidents*, L. V. Chilton and I. D. Wratten; *Treasurer*, H. Abbott; *Ordinary Members of Council*, Gilbert Adams, S. W. Bowler, G. Scott Bushe, J. Allan Cash, K. H. Gaseltine, P. Hansell, Miss M. Harker, R. G. Hopkinson, T. Midgley Illingworth, J. Dudley Johnston, H. S. Newcombe, Anthony Peacock, B. Sinkinson, A. L. McR. Sowerby and H. White.

"Production of Mesons by Electrons"

Dr. I. N. Sneddon and B. F. Touschek write, with reference to their communication under this title published in *Nature* of April 2, p. 524: "The second row of the table of numerical values gives $10^4\ I(E)$ and not $10\ I(E)$ as stated there. The second sentence of section (3) should be amended to read: 'By analogy with *Bremsstrahlung* we might expect the cross-section for an atom with charge Z to be larger by a factor Z^2. It turns out that this factor is incorrect, since for any nucleus a competing intermediate state occurs: . . .' Further, the factors occurring in the second last paragraph should read: 'Z for positive mesons, and $A-Z$ for negative mesons'. This changes the final cross-section to 10^{-31} cm.^{2}. It has been pointed out to us by Prof. J. C. Gunn, that the 'mixed term' in the Hamiltonian of the interaction between a meson and the electromagnetic field may give rise to an appreciable correction to the values of $I(E)$. This suggestion is now being considered and will be discussed in a future publication."

Announcements

A COURSE on the application of air photography to planning will be held at University College, London, during July 18–29 under the direction of the professor of surveying and photogrammetry (Prof. C. A. Hart). The fee for the course will be ten guineas, and full details may be obtained from the Secretary, University College, Gower Street, London, W.C.1.

THE second full-day conference on combined heat and power supplies, organised by the Institute of Fuel, will be held at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, on April 27. This conference will deal with the interlinking of the heat and power systems of adjoining industrial plants, and also with the co-ordination of heat and power supplies and demands throughout a district. The conference will be open to the public, and full particulars may be obtained from the Secretary, Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1. For further consideration of general and regional aspects of the problem, the North-Western Section of the Institute is holding a conference on the same subject at the Engineers' Club, Albert Square, Manchester, on May 11.

THE Department of Scientific and Industrial Research will consider applications for maintenance allowances from graduates (or equivalent) in science who wish to be trained in applied science, industrial research or technology. Such allowances may only be held in a university, institution or approved research association. Applications for the academic year 1949–50 must be made on Form 1*S* and must be completed before May 1. Full details may be obtained from the Department of Scientific and Industrial Research, Dorland House, 14–16 Regent Street, London, S.W.1.

REFERRING to the article entitled "Fracture of Solids" published in *Nature* of March 5, p. 376, Mr. M. W. Thring writes: "The report of Dr. Haward's observations is not quite correct in that the log T, $1/S$ relation is ascribed wholly to Dr. F. W. Preston. This relation is based on Preston's work, but was published by Haward (*J. Soc. Glass Tech.*, **28**, 427; 1944) prior to its independent publication by Preston (*Nature*, **156**, 55; 1945)".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Inorganic Paper Chromatography

PROF. R. P. LINSTEAD kindly sent me a manuscript copy of the communication by Burstall, Davies, Linstead and Wells[1], and I should like to comment on this work in relation to my own.

Prof. Linstead and his colleagues mention that more precise separations were achieved by them by downward development; this technique was tried by me[2], but more constant R_f values are obtained by Williams and Kirby's method[4].

It is mentioned[1] that separations of gold, platinum, palladium, iridium and rhodium have been carried out by the authors. I have since devoted some more time to the platinum metals, including ruthenium and osmium, and intend to publish my results in the near future.

My results on the separation of the copper and tin groups were accepted by *Analytica Chimica Acta* on September 24, 1948, in advance of Arden, Burstall, Davies, Lewis and Linstead's first publication[3], and is at present in the press.

More recent work of mine includes the following. Silver chloride, mercurous chloride and lead chloride can be separated on a disk of filter paper by placing approximately 0·1 mgm. in the centre and adding two drops of water followed by two drops of 5*N* ammonium hydroxide as developing solvent. After exposure to hydrogen sulphide, this produces a centre patch of black mercury and mercury sulphide surrounded by a ring of silver sulphide, again surrounded by a ring of lead sulphide.

Divalent copper and cadmium can be separated by the technique described in ref. 3 by the use of 25 per cent ethyl alcohol as developer.

Divalent lead can be separated from divalent copper, cadmium and mercury, and trivalent bismuth by development with 1*N* aqueous hydrochloric acid; but the lead does not travel with the liquid front.

Using butanol saturated with 1*N* hydrochloric acid, the following R_f values were obtained:

Ion	R_f value	Ion	R_f value
Ag^+	0·0	Hg^{++}	1·02–1·10
Cu^{++}	0·08–0·13	Pt^{+++}	0·72–0·8
Cd^{++}	0·56–0·65	Rh^{+++}	0·07
Bi^{+++}	0·61–0·68	$RuO_4^=$	0·1
Pb^{++}	0·0	Ir^{++++}	0·72–0·8*
As^{+++}	0·67–0·73	Au^{+++}	1·05–1·13
Sb^{+++}	approx. 0·8*	Fe^{+++}	0·12
Sn^{++}	0·95–0·99	Co^{++}	0·07
$MoO_4^=$	0·5–0·53	Ni^{++}	0·07
UO_2^{++}	0·2	Mn^{++}	0·09
U^{++++}	0·0	Sr^{++}	0·0
Pd^{++}	0·6	Ba^{++}	0·0

* Further details are necessary.

Investigations with other solvents were also carried out; for example, hydrobromic, hydriodic, acetic, nitric and phosphoric acids, in butanol, etc.

On January 25, 1949, I submitted a paper to *Science* giving the details of the separation of chloride, bromide, iodide and thiocyanate ions, which is achieved by using butanol saturated with 2*N*; the following R_f values were obtained:

Anion	R_f value
Cl^-	0·10–0·11
Br^-	0·15–0·18
I^-	0·29–0·32
CNS^-	0·42–0·48

For separation of smaller quantities a new technique, which I call micro-chromatography, was developed and announced to some of my colleagues in this field on December 31, 1948, in a private communication. Further details will appear in due course.

The above deals only with inorganic work. In addition, I have dealt with a number of theoretical points, including: a thermodynamical treatment of temperature variations; new aspects of 'comet' formation; generalizations concerning the effect of different anions on the R_f values of cations.

MICHAEL LEDERER

Chemistry Department,
Sydney Technical College,
Australia. Jan. 26.

[1] [See *Nature*, January 8, p. 64.]
[2] Arden, Burstall, Davies, Lewis and Linstead, *Nature*, **162**, 691 (1948).
[3] Lederer, M., *Analytica Chimica Acta*, **2**, 261 (1948), received by the editors on March 20, 1948.
[4] Williams, R. J., and Kirby, H., *Science*, **107**, 481 (1948).

THE spread of interest in inorganic adsorption analysis using organic solvents, indicated in Mr. Lederer's communication above and in the recent letter from Pollard, McOmie and Elbeih[1], is welcome, as it does seem that the method will have wide applications. We have tried to make its possibilities generally known both in our preliminary communications[2], by demonstrations[3], and by privately advising a number of research laboratories on applications to their individual problems.

The further development of this method may proceed along many different lines. One possibility is to compare the behaviour of a large number of different metals with standard solvents or solvent mixtures. This could conceivably lead to the separation of complex mixtures of metals in two-dimensional chromatograms, rather as has been done with amino-acids. It is interesting that both Mr. Lederer and the Bristol workers are collecting comparative data suitable for this purpose. It is, of course, necessary to bear in mind that the rate of movement of a particular metal (as represented, for example, by its R_f value) may be affected by other ions present. Another line of attack is to devise special methods for particular and more limited mixtures. Thus a group of metals can be precipitated in some standard way, and paper chromatography used as a supplementary weapon for analysis or purification. This is a line of development which we think very attractive, and one topic which we are now studying particularly is the possibility of eluting one metal after another from a paper strip or column by successive changes of the extracting medium. Separations involving some forty-five metals and anions have so far been achieved in this Laboratory. Details will appear elsewhere.

In view of the increasing interest in this subject it may be well at this stage to make a few historical matters clear. The separation of organic substances from aqueous solutions by capillary analysis was first due to Goppelsroeder[4], while it appears that H. Trey[5] achieved the first clear inorganic separations by this technique. The fractionation of inorganic compounds in aqueous solutions by means of adsorption columns was first effected by Schwab and his co-workers[6]. The great advance of the separation of *organic* compounds on paper using organic solvents was due to Martin, Gordon, Synge and their collaborators[7]. We appear to have been the first to have described the use of *organic* solvents for separating *inorganic* materials on cellulose, although it now

appears that work on these lines has proceeded independently in other laboratories. Our experiments in this field began in 1946 and were described in the Annual Report of this Laboratory for 1947 [5] and in subsequent communications[6].

We did not overlook Mr. Lederer's 1948 paper[7]; but it was not referred to individually in our previous letters as it dealt with aqueous solutions. For the same reason we did not detail all the earlier work with aqueous solutions, but confined ourselves to the remarkable improvements which are possible when organic solvents are used under the best conditions.

R. P. LINSTEAD

Chemical Research Laboratory,
Teddington.

[1] *Nature*, **163**, 292 (1949).
[2] *Nature*, **162**, 691 (1948); **163**, 64 (1949).
[3] *Nature*, **163**, 235 (1949).
[4] Goppelsroeder, F., "Kapillaranalyse" (Dresden, 1910).
[5] Trey, H., *Z. anal. Chem.*, **37**, 743 (1898).
[6] Schwab, G. M., and Jockers, K., *Naturwiss.*, **25**, 44 (1937).
[7] Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **37** (1), 79 (1943).
[8] Report of the Chemistry Research Board, 1947 (H.M. Stationery Office).
[9] *Analytica Chimica Acta*, **2**, 261 (1948).

Mechanism of Nitration of the Aromatic Nucleus

IN order to check the constitution of preparations of the three different tritium toluenes carrying radiochemical amounts of tritium in the aromatic nucleus, samples were transformed into 2,4-dinitrotoluene with an excess of a mixture of 1 part (by volume) of concentrated nitric acid and 2 parts of concentrated sulphuric acid. An experiment in which inactive toluene was nitrated with a rather strongly active mixture of acids showed that no hydrogen exchange takes place under the conditions of the reaction. No activity could be detected in the dinitrotoluene, though it had been possible to record an acquired tritium : protium ratio as small as 1 per cent of that of the surrounding mixture of acids and water, even if only one of the organic hydrogen atoms had taken part in the exchange.

It was to be supposed that on dinitration toluene-4-t would lose all, and toluene-3-t none, of its activity. Toluene-2-t, finally, would lose an amount corresponding to the relative velocities of nitration in the two ortho positions, carrying tritium and protium, respectively.

The different organic molecules were burnt and the specific activities of the water samples determined[1]. In the calculation of the percentage of tritium remaining in the molecule after nitration, the different hydrogen contents of toluene and its dinitro derivative were taken into account. The accompanying table gives the results.

In the case of toluene-4-t some other isomer seems to have been present in the sample.

In the case of toluene-2-t, both experimental figures equal 50 per cent just within the experimental error, which implies that the nitration proceeds with very nearly the same velocity irrespective of whether tritium or protium originally occupies the position. In view of the great difference in mass (and therefore in the zero point energy of the original bond, the difference in which, however, may be more or less counterbalanced by a similar difference of the same magnitude in the 'activated complex' of the reaction, particularly if a base enters the complex[2]), it seems natural to suppose that the velocities should be different if the splitting off of the hydrogen takes part in the rate-determining step of the attack on the nucleus (which is not necessarily that of the reaction as a whole). Since there is no exchange of hydrogen with the acids and the water, the reason cannot be the existence of a dissociation equilibrium. The simplest way of accounting for the present observation seems to be the assumption of an addition of the nitrating agent (NO_2^+) [3,4] as the rate-determining step, followed by a rapid splitting-off of the hydrogen. The intermediate ion might have a quinonoid character.

Substance nitrated	Percentage of original tritium still present in the 2,4-dinitrotoluene	
	Theoretical	Observed
Toluene-4-t	0 per cent	2·2 per cent
Toluene-3-t	100	99·0
Toluene-2-t	(50)*	51·9; 49·7 (two exp.)

* On the assumption of equal nitration velocity in tritium and protium positions.

LARS MELANDER

Nobel Institute for Physics,
Stockholm 50. Oct. 25.

[1] Melander, L., *Acta Chem. Scand.*, **2** (In the press).
[2] Bennett, G. M., Brand, J. C. D., James, D. M., Saunders, T. G., and Williams, G., *J. Chem. Soc.*, 474 (1947).
[3] Bennett, G. M., *et al.*, several papers in *J. Chem. Soc.*, 1946 and 1947.
[4] Ingold, C. K., *et al.*, several communications in *Nature*, **158** (1946).

Kinetics and Mechanism of Aromatic Nitration

IN an earlier note[1] it was shown how the study of the kinetics of nitration, particularly the study of reaction order, established (*a*) the formation of the nitronium ion, and (*b*) its effectiveness as the entity which attacks the aromatic molecule. Further kinetic investigation, particularly of salt and solvent effects, has given information on two other general features of the reaction. They relate to (*c*) the reaction stages by which the nitronium ion is formed, and (*d*) those by which it becomes a nitro-group in the aromatic compound.

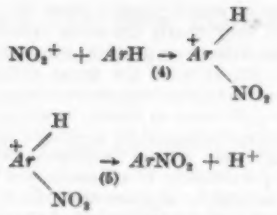
(*c*) The stages by which the nitronium ion is formed may be discovered by reference mainly to conditions in which the rate of nitration is equal to the rate of formation of the nitronium ion. For the formation of nitronium ion from nitric acid, the stages are as follows :

$$2HNO_3 \underset{(2)}{\overset{(1)}{\rightleftharpoons}} H_2NO_3^+ + NO_3^- \qquad \text{(1 and 2 fast)}$$

$$O_2N \cdot \overset{+}{O}H_2 \xrightarrow[(3)]{} O_2N^+ + OH_2 \qquad \text{(3 slow)}$$

The proof of this rests on a hyperbolic repression by nitrate ions of the rate of nitration ($v \propto c^{-1}$), without disturbance to the reaction order, even when it is of zero order. Other sufficiently strong acids, such as sulphuric acid, may replace one molecule of nitric acid in providing the proton required for the formation of the nitric acidium ion, as illustrated in (1).

(*d*) The stages by which the nitronium ion enters the aromatic ring are elucidated by reference mainly to conditions of nitration in which the nitronium ion is rapidly formed. The transformation of the nitronium ion into an aromatic nitro-group is a two-stage bimolecular process, the proton-loss having no kinetic significance :



This follows because the solvent effect, under the conditions indicated, is small enough to show that ionic charges are neither formed nor destroyed in the rate-determining stage of the entry of the nitronium ion as a nitroxyl group into the aromatic molecule. The alternative possibility, that the reaction is a one-stage termolecular process, in which the proton-loss is kinetically important, requires the reaction to be base-accelerated, and therefore, since the strongest available bases are nearly always anions, requires ionic charges to be destroyed; for example:

$$NO_2^+ + ArH + SO_4H^- \underset{(6)}{\rightarrow} ArNO_2 + H_2SO_4.$$

Reaction (6) should be comparable to (2), or in an inverse sense to (1), in solvent sensitivity, and this the reaction between nitronium ions and aromatic molecules certainly is not. Reaction (4) should show a small solvent effect due to the spreading of the charge in the transition state; and the actual reaction does, indeed, exhibit such an effect.

We were commencing an investigation, in which we expected to confirm the kinetic insignificance of the proton-loss by showing that aromatic protium and deuterium are replaced by nitroxyl at the same rate, when Dr. Melander very kindly sent us word that he had just completed such a demonstration, but using tritium rather than deuterium. His work is conclusive (see preceding communication).

The effect of small amounts of water in accelerating nitration in sulphuric acid has been interpreted[2] as a mass-law effect on the basis of (6). We think that the phenomenon which in the simplest circumstances comes under observation here is the small solvent effect on (4). From the dielectric properties of sulphuric acid, and its behaviour in solvating cations, it seems certain that the first effect of added water must be to reduce solvating power, and thus to create a kinetic effect in the observed direction[3]. Actually a complication enters in nearly all real cases, as has already been pointed out[4]. It is that most substances of which the nitration-rates in sulphuric acid have been studied combine with the acid to form unreactive salt-like complexes, which added water will partly break up, thereby facilitating nitration. But when this effect is negligible or absent, the solvent influence on (4) remains as a factor which will cause a small initial acceleration by added water.

R. J. Gillespie C. K. Ingold
E. D. Hughes D. J. Millen
R. I. Reed

Sir William Ramsay and
Ralph Forster Laboratories,
University College,
London, W.C.1.

[1] Hughes, Ingold and Reed, *Nature*, **158**, 448 (1946).
[2] Bennett, Brand, James, Saunders and Williams, *J. Chem. Soc.*, 474 (1947).
[3] Gillespie, Hughes and Ingold (forthcoming papers).
[4] Gillespie and Millen, *Quart. Rev. Chem. Soc.*, **2**, 277 (1948).

Monolayers of Collagen

Past work on monolayers of gelatin on water has generally led to the conclusion that it is not suitable for such studies because of its high solubility[1]. This difficulty has been overcome with other proteins by spreading on strong solutions of ammonium sulphate[2], and we have found that stable monolayers of collagen can be formed on 30 per cent ammonium sulphate solution (*p*H 4) by spreading from formic acid solution. The surface pressure (π) and surface potential (ΔV) have been studied over a pressure-range of 0·01–30 dynes/cm. When the area (A) is greater than about 5 m.²/mgm. the film is heterogeneous, large fluctuations of ΔV being observed as the ionizing air-electrode is moved over the surface, although no constant surface vapour pressure was found. As the film is compressed to areas smaller than about 5 m.²/mgm. it becomes homogeneous and $\Delta V.A$ is constant. On further compression, two critical areas are recognized: (1) A_1 (1·8 m.²/mgm.), below which values of $\Delta V.A$ fall, indicating a change in orientation, accompanied by a decrease in compressibility; (2) A_2 (1·3 m.²/mgm.), which is derived by extrapolating the linear portion of the π—A curve (between 1·0 and 0·2 m.²/mgm.) to zero pressure.

We suggest that these two areas correspond to close-packing of the polypeptides with their side-chains orientated (*a*) parallel to, and (*b*) perpendicular to the water surface. From existing data on the amino-acid composition of collagen[3], these areas are found to correspond to about 27·5 and 20 A.² per mean residue, respectively. Calculations based on the mean side-chain length and Astbury's mean repeat distance of 2·85 A. for collagen give a value for A_1 of 28·2 A.² per mean residue, assuming that ends of the 'mean' side-chains approach to within the H—H covalent bond distance. The determined value for A_1, of 20 A.²/mean residue, is very near that for close-packed fatty acids, amides, etc., with the side-chains practically vertical. This area has been observed with several other proteins (for example, Philippi[4]). Compression to areas smaller than A_2 must result in the displacement or solubilization of parts of the film.

When collagen was spread on solutions of hydrochloric acid and sodium chloride, stable and reproducible films were formed when the film was initially spread at areas larger than A_1. Poor reproducibility resulted when the initial area was less than A_2. By studying the π—A curves over a range of *p*H values and salt contents, the following two distinct phenomena are apparent:

(1) At areas larger than A_1, the π—*p*H curves at constant area show a maximum at *p*H 2·2, sodium chloride causing the maximum to be depressed and, when present in sufficient amount, to disappear (see Fig. 1).

(2) At areas smaller than A_2, the π—*p*H curves show no maxima whether or not salt is present, π increasing as the ionic strength of the solution increases, that is, as the *p*H decreases (see Fig. 2). None of the π—A curves gives a linear portion which can be extrapolated to zero pressure.

At areas greater than A_1, where the molecules are probably orientated with the side-chains parallel to the surface, the dependence of the two-dimensional osmotic pressure (π) on *p*H and salt is similar to that predicted by the three-dimensional Donnan theory, or by consideration of the electrical properties of the film

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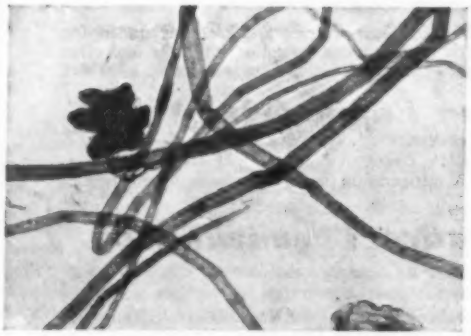

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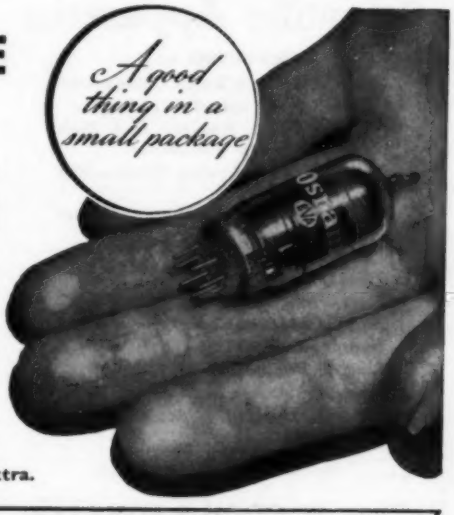

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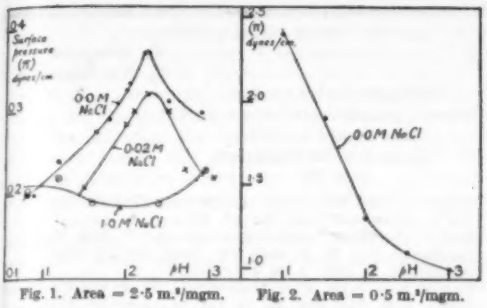

Fig. 1. Area = 2·5 m.²/mgm.

Fig. 2. Area = 0·5 m.²/mgm.

as deduced by Philippi[4] from the Gouy–Chapman treatment of the ionic distribution in the electrical double layer. At areas smaller than A_2, where it is impossible for all the film to remain in the surface, the action of both acid and salt appears to be that of 'salting-out' agents, the increasing ionic strength necessitating more work to cause displacement.

Our thanks are due to the Director and Council of the British Leather Manufacturers' Research Association for permission to publish this communication.

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Measurement of the Elasto-Plastic Properties of Gels

Cheftel and Mocquard[1] used the deflexion of a vane embedded in a gel to record the relation between the deformation of the gel and the applied force.

Goldsmith and Iball[2] showed that, if the vane is attached to a torsion wire and deflected by an angle δ with the torsion head turned through an angle α, the blade deflexion at time t is given by

$$\ln \{\alpha/(\alpha - \delta)\} = Ct^k/\Psi, \qquad (1)$$

where C is a constant of the instrument, Ψ a constant of the gel denoting its firmness and k the dissipation coefficient. Equation (1), which thus permits calculation of the 'firmness intensity factor' Ψ, was found to be applicable to a number of different milk curds for which the index β of the applied stress was unity and where the elastic limit was exceeded at a negligibly small applied stress.

Further experiments have shown that the torsion method can also be used to find the rheological properties of gels which possess considerable elasticity. In this case, the apparent 'firmness intensity factor' is composed of an elastic and plastic component, the former being independent of time and thus determined by the shear strain at $t \simeq 0$, whereas the latter is dependent on the relation between shear strain and time at $t > 0$. A modification of equation (1) is thus necessary to account for the elasticity of the gel, the modified equation taking the form:

$$\ln \{\alpha/(\alpha - \delta)\} = C(1/E + t^k/\Psi), \qquad (2)$$

where E is the modulus of elasticity.

The following figures were obtained by means of equation (2) for the gels formed by 1 per cent solutions of commercial soaps at 25° C. ($\beta = 1$).

Sample	E (dynes/cm.²)	ψ (c.g.s. units)	k
I	7·0	261	0·590
II	27·1	172	0·402
III	42·7	78·5	0·256

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Oct. 13.

[1] Cheftel and Mocquard, *J. Soc. Chem. Indust.*, **60**, 184 (1947).
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Volatility of the Oxides of Tungsten and Molybdenum in the Presence of Water Vapour

According to L. Wöhler and O. Balz[1,2], the oxides WO_3, W_2O_5 (W_4O_{11}) and WO_2 volatilize considerably above 800–900° C., and the vapour pressure of tungsten trioxide is, according to O. Ruff and Grieger[2,3], 0·206 mm. at 1,023° C. It is generally believed that this phenomenon explains the formation of much larger metal grains during the reduction of tungsten trioxide in hydrogen at 800–900° C. from much finer oxide grains.

Our experiments have, however, shown that the known oxides, WO_3, W_4O_{11} and WO_2, do not sublime at an appreciable rate under 1,000° C. either *in vacuo* or in a stream of a neutral gas. For example, 0·5 gm. of any of the oxides in a quartz tube at a pressure of 1/1,000 mm. gave only insignificant traces on the cold part of the tube during 58 hr. at 1,000° C., and only 1–5 mgm. during 8 hr. at 1,300° C. Similarly, less than 0·5 gm. volatilized at 1,000° C. during 1 hr. of the same quantity of WO_3 in a stream of oxygen (velocity 100 l./hr./2 sq. cm.) and an even smaller quantity of W_4O_{11} or WO_2 in a stream of purified argon (velocity 10 l./hr./2 sq. cm.).

The known oxides of tungsten volatilize, however, readily at 1,000° C. at a pressure of 1 atm. in the presence of water vapour (see Table 1).

This table clearly indicates that, under these conditions, the sublimation of WO_3 in moist air, oxygen

Table 1

1 atm., 1,000° C.							
	Carrier gas	Water (vol. %)	v, streaming velocity (l./hr./2 sq. cm.)	Time (hr.)	Weight of oxide (mgm.)	m, sublimed mass (mgm.)	k
WO_3	Oxygen	0	100	1	470	0·3	—
		0·4	100	1	490	1·2	30
		2	4	1	460	1·6	40
		29	113	1	470	120·6	39
		75	40	1/2	480	70·5	30
		100	30	1/2	470	81·3	30
W_4O_{11}	Argon Hydrogen	0	10	1	510	0·1	—
		86	34	1/2	540	63·3	24
WO_2	Argon Hydrogen	0	10	1	330	0	—
		59	41	1	140	39·6	37

or water vapour, of W_4O_{11} in a mixture of hydrogen and water containing 64–94 per cent water, and lastly of WO_2 in a mixture of hydrogen and water containing 49–64 per cent water (both mixtures assuring an invariant composition of the W_4O_{11} and WO_2 respectively[4]), is so rapid that during a few hours a substantial deposit would be produced. The speed of sublimation (the material volatilized in an hour) can be expressed with the notation of Table 1 approximately as follows:

$$m = k \text{ (vol. per cent)} \sqrt{v}.$$

The deposited WO_2 is a greenish-yellow crystalline powder, the W_4O_{11} crystallizes mainly in violet needles, and WO_2 gives a gold-brownish mirror of metallic lustre.

Searching for similar effects with the oxides of other metals, it was found that water vapour is capable of enhancing—if only to a smaller extent—the volatility of molybdenum trioxide (MoO_3) also (see Table 2).

Table 2

	Oxygen, 1 atm.					
	Water (vol. %)	v, streaming velocity (l./hr./2 sq. cm.)	Temperature (t °C.)	Time (hr.)	Weight of oxide (mgm.)	m, sublimed mass (mgm.)
MoO_3	0	80	600	1/2	892	0·5
	66	59	600	1/2	880	8·5
	0	80	700	1/2	892	15·0
	66	59	700	1/2	870	92·3

The sublimation of the above-mentioned oxides is therefore interesting, for WO_3, the hydrate of composition of which, WO_3H_2O, decomposes entirely when heated to 300° C., in its solid phase is unable to combine with more water molecules at higher temperatures, but can, however, easily combine with the water present in the gaseous phase. This phenomenon cannot be regarded as a water vapour-distillation, because there is no liquid phase. It must be emphasized that it is the oxides themselves which condense from the gaseous phase and not a hydrate. So it seems that the water molecules can form bonds in the gaseous phase strong enough to dislodge the oxides from the crystal lattices. We are of opinion that the generally known tendency of the W^{6+} and W^{4+} ions to be octahedrally co-ordinated[5,6,7] with $O^{=}$ favours the formation of separate molecules (for example, $WO_3.3H_2O$, etc.) in the gas, in contrast with the distorted octahedrons found in their lattices[5,6].

This property serves to explain C. J. v. Nieuvenburg and H. B. Blumendal's observation[8], who have found that solid tungsten trioxide can be dissolved in water vapour near the critical region, at 380° C., at 275 atm. Similarly, the pneumatolytic origin of tungsten ores can be accounted for; and the suggestion of the dominant role of water vapour near the critical pressure appears superfluous, for these ores can be formed at atmospheric pressure, too.

The sublimation of the oxides of molybdenum and tungsten can be used for analytical purposes and for the purification of the oxides. Tungstates cannot be attacked by water vapour.

The above investigations clearly indicate that it is not the spontaneous volatility of the tungsten oxides, but the volatility induced by water vapour, which is the main factor of the phenomenon, thoroughly investigated in the incandescent lamp industry, that by reduction with hydrogen the fine tungsten trioxide gives a much coarser metal powder.

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Oct. 21.

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Mechanism of the Fischer Indole Synthesis

Sir Robert Robinson (private communication) has commented that our interpretation[1] of the cyclizations of mixed hydrazones may be more simply explained by assuming that the hydrazones may be hydrolysed initially in glacial acetic acid medium, and then the free phenylhydrazines and *cyclo*hexanones recombine to form the different tetrahydrocarbazoles mentioned (*loc. cit.*).

Although it has not been possible to investigate this criticism completely, nevertheless it has been found by us that, when the *o*-tolylphenylhydrazone of *cyclo*hexanone is cyclized in glacial acetic acid in the presence of phenylhydrazine, appreciable quantities of carbazole can be obtained after dehydrogenating the product.

This indicates that the above criticism is very pertinent, and that our interpretation is only one of the alternatives. Further investigation is in progress.

K. H. Pausacker

Chemistry Department,
University of Melbourne.

[1] Pausacker and Schubert, *Nature*, **163**, 289 (1949).

A Method of Mounting Filamentous Materials for Spectroscopic Examination in the Infra-Red

Spectroscopic examination of filamentous materials in the infra-red has hitherto been far from easy owing to the difficulty of obtaining a satisfactory specimen mount. A twisted bundle of filaments cannot be used, partly because the effective thickness of such a sample is generally excessive, and partly because the amount of radiation scatter which it produces is far too great. For nylon filaments these difficulties have been overcome by the use of the mount described here.

The device consists essentially of two rectangular U's, made from ½-in. carbon steel plate, between which is a strip of thin metal spacer foil, the plates being clamped together by means of two countersunk screws tightening into tapped holes in one of the plates. The gaps between the limbs of the U's are each ¾ in., that is, slightly less than the length of the spectrometer slit. The inside faces of the plates are carefully ground and lapped flat so that they will stick together by mutual cohesion. The tips of the U's are given a slight chamfer so that the filaments may be inserted more easily. The thickness of the spacer foil should be one or two ten-

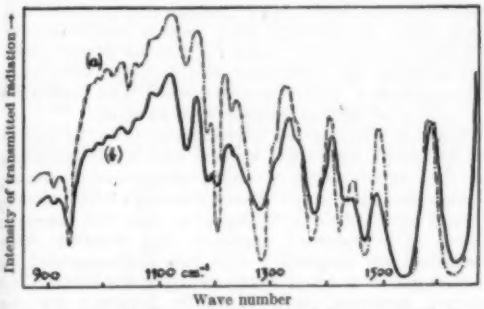
thousandths of an inch less than the diameter of the fibres to be mounted.

In preparing a specimen it is convenient to clamp the mount to a glass plate and place it in the field of view of a binocular microscope. Single filaments, 4–6 in. in length, are then inserted one by one into the slots, bringing the first right up to the edge of the spacer metal and packing each succeeding filament as closely as possible to the last. Adequate packing can be obtained by inserting periodically a second strip of spacer metal into the jaws of the mount, using this to press the filaments closely together. Each filament can be held after mounting by embedding its ends in lumps of 'Plasticine' on the glass plate.

The number of filaments that must be mounted in this way will depend on their diameter and on the spectrometer slit width; for nylon filaments 0·008 in. in diameter it is sufficient to mount 40–50. When the required number have been placed in position, a final piece of metal foil is inserted to help preserve the alignment of the mounted filaments, and also to prevent any radiation passing directly into the spectrometer around the edges of the grid in the event of the specimen being moved while measurements are in progress.

The filaments are then stuck down to the outside edges of the steel plate by a thick cement, after which the cemented portion is covered with transparent adhesive tape. The loose filament ends and the protruding ends of the spacer metal are trimmed off.

The radiation scatter from the filaments so mounted is not excessive, and the effective thickness is low enough to allow reasonably small slit widths to be used, so that satisfactory spectra can be obtained from it directly. If desired, however, the scatter can be reduced by moistening the filaments with 'Nujol', and placing a small rock-salt window on each side, holding the windows in position by a small brass clamp.



A comparison of the instrumental records obtained from (*a*) a nylon film and (*b*) a grid of nylon filaments. (*a*) Nylon film, 20 μ thick; spectrometer slits 0·3 mm. (*b*) Grid of 20 μ diameter filaments: spectrometer slits 0·4 mm.

In the accompanying drawing, the transmitted radiation obtained from a filament grid (continuous line) is compared with one from a nylon film (broken line). For the grid, composed of filaments 20 microns in diameter, the spectrometer slits were set at 0·4 mm.; for the film, 20 microns thick, the slits were 0·3 mm. wide.

P. Holliday

Research Department,
British Nylon Spinners, Ltd.,
Coventry.
Aug. 19.

Measurement of Small Surface Angles

It has been established that multiple-beam fringes of equal chromatic order are particularly sensitive for the evaluation of small surface angles. Yet they suffer from a disadvantage in that the angle shown by the fringes depends upon the orientation of the surface relative to the spectrograph slit. In fact, a resolved component of any surface angle appears, and in general it is necessary to rotate the surface under observation to find the maximum corresponding to the true surface angle.

This difficulty can be avoided by the combined use of superposition of fringes of equal chromatic order with Fizeau fringes, on the same photographic plate, as follows. Consider a simple wedge between two planes, one vertical with the edge perpendicular to the spectroscope slit. This leads to the formation of a family of fringes of equal chromatic order the shape of which depends upon the wedge angle and the spectrograph dispersion. If y_1 is the vertical distance between two fringes, then the wedge angle is $\tan^{-1} \lambda_1/2y_1$. However, in the general case the edge of the wedge is not perpendicular to the slit, and if φ is the angle made by the edge and the slit, then the true angle of the wedge θ is given by the relation $\tan \beta = \tan \theta \sin \varphi$, where β is the apparent angle given by the fringes of equal chromatic order, that is, $\tan \beta = \lambda_1/2y_1$, when y_1 is the vertical distance between two fringes. However, the Fizeau fringes from a wedge are straight lines parallel to the edge; hence the angle φ is simply the angle made by the Fizeau fringes with the slit, that is, with any spectral line. Clearly a superposition of the two systems enables φ to be measured.

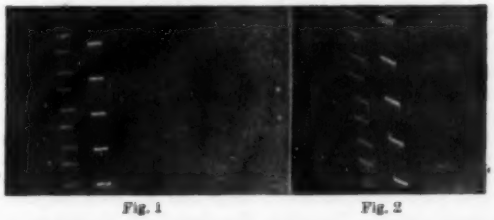


Fig. 1 Fig. 2

This is obtained very easily in practice. The narrow fringes of equal chromatic order are first photographed with the usual source of white light, using a narrow slit. Without moving either the interference system or photographic plate, the slit is opened wide and the source of white light replaced by a mercury arc. Fizeau fringes are thus superposed on the fringes of equal chromatic order, as shown in Fig. 1. This is the special case of a wedge set with $\varphi = \pi/2$, and the Fizeau fringes are horizontal. The Fizeau fringes assist in identifying the intercept of a vertical line with successive fringes of equal chromatic order. In the case shown $\tan \theta = 0{\cdot}001$.

Fig. 2 illustrates the appearance when the wedge happens to be set with $\varphi = 60°$, and it is easy to see how the formula given above enables θ to be derived. Even with such low dispersion, the angle calculated from Fig. 2 agrees with that from Fig. 1 to within about 1 per cent.

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Quantitative Researches on the Optical Properties of Human Bone

THE quantitative studies of Dallemagne and Mélon[1] on the optical properties of ox bone (already described in part in *Nature*[2]), and their deductions concerning the relations between the organic and the inorganic fractions of the bone, have led me to a series of analogous, independent researches on human bone.

In specimens from subjects three to sixty years old, the index of refraction at room temperature of air-dried human bone (femoral diaphysis) was found to be almost constant and ranged around 1·560 ± 0·002. From birth until the age of three years, the index of refraction appears to rise at an increasing rate from 1·549 to 1·560. In the seventh and eighth decades, there is a small but noticeable increase: 1·564 ± 0·002. Bone from which the organic fraction has been removed shows a particularly interesting behaviour which to my knowledge has not been pointed out before: the index of refraction estimated by the methods of Becke and Schröder van der Kolke varies in value according to the nature of the comparison fluids. A value of 1·600 ± 0·002, almost constant for all ages, is obtained by using a mixture of oil of lavender and oil of cinnamon, which in all probability gives results more closely approximating the real values. Technical difficulties do not allow precise measurements of the index of refraction of fresh bone or of bone deprived of its mineral fraction. However, it is probable that the index of refraction of fresh bone from adult subjects is not less than 1·540.

The birefringent power of normal human bone ranges about + 0·004, as determined from measurements on seven subjects of 1, 3, 7, 11, 25, 50 and 80 years of age.

The quantitative researches clearly agree with the fact, already observed qualitatively by Schmidt[3], that normal human bone, deprived of its organic fraction, follows Wiener's law[4] of birefringence of form (*Formdoppelbrechung*). The parabolic curve of birefringence of form has a negative vertex. It follows from this that the mineral fraction of the bone is anisotropic and has its own negative birefringence (*Eigendoppelbrechung*). With due reservations on the more or less perfect penetration of the fluids in bone deprived of its organic fraction, the birefringent power of the mineral fraction is not constant, but varies with the age, tending to diminish rapidly in the first years of life, while remaining practically stationary during adult and old age.

The conclusions which Dallemagne and Mélon[1] wish to draw from their researches on the optical properties of ox bone, namely, "La fraction organique de l'os, représentée par l'osseine, n'accuse . . . aucun lien chimique perceptible aux méthodes physiques avec le phosphate tricalcique, élément principal de la fraction minérale", do not seem to me acceptable without reserve, and this for two fundamental reasons: (1) A chance coincidence may be responsible for the identical values obtained by these authors for the total birefringence measured directly and for the indirectly calculated birefringence. Indeed, the index of refraction and the relative volume of the organic substance measured by Dallemagne and Mélon do not apply only to the fundamental interfascicular substance (*Kittsubstanz*) to which the mineral fraction is bound, but rather to the complex mass consisting of fundamental substance + collagen fibres. (2) Dallemagne and Mélon also do not take into consideration the birefringence of the organic substance (fundamental substance + fibres), which certainly has an influence on the value of the total birefringent power of the bone.

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Synthesis of γ-Glutamyl Peptides

IN the classical synthesis by Bergmann and Zervas[1], carbobenzoxy L-glutamic anhydride reacts with amino-acid esters to yield, after saponification and hydrogenation, α-glutamyl peptides. There have, however, been indications that the anhydride ring may not open exclusively in this direction. Bergmann[2] reported that glycylglycine ethyl ester yields a mixture of the α- and γ-derivatives, and in the analogous reaction with ammonia Melville[3] found some 14 per cent glutamine admixed with the *iso*-glutamine. Anomalies have also been observed in the opening of the ring of carbobenzoxy L-aspartic anhydride[4].

In the course of an investigation of ring openings of this type, we have examined the reaction of carbobenzoxy L-glutamic anhydride with cold aqueous hydrazine. The crystalline product, isolated in nearly quantitative yield (m.p. 170–171°), was found to be a mixture of the α- and γ-hydrazides, which could not be separated by repeated crystallization. Conversion to the azide and coupling with glycine ethyl ester gave a product from which carbobenzoxy α-L-glutamyl glycine could be isolated in low yield, but which on saponification and hydrogenation gave a mixture of α- and γ-peptides, since with ninhydrin 0·8 moles of carbon dioxide were evolved.

We were therefore led to prepare pure carbobenzoxy γ-L-glutamyl hydrazide by the action of hydrazine on the carbobenzoxy γ-ethyl-L-glutamate of Abderhalden and Nienburg[4]. This hydrazide, which clearly should provide an unambiguous path for the synthesis of γ-glutamyl peptides, has recently been described by Hegedüs[5], who has demonstrated its usefulness in a novel synthesis of glutathione. We record, however, m.p. 178–179° (uncorr.) for our carbobenzoxy γ-L-glutamyl hydrazide, which we obtained in quantitative yield on treating the ester with hydrazine in aqueous ethanol at 20° for 48 hours (found: C, 52·7; H, 5·9; N, 14·0; $C_{12}H_{17}O_5N_3$ requires C, 52·86; H, 5·81; N, 14·23 per cent. $[\alpha]_D^{18}$ − 13·4° ± 0·4° in 0·5 *N* hydrochloric acid, *c*, 6·4; $[\alpha]_D^{18}$ − 5·1° ± 0·3° in water containing 1 equiv. NaOH, *c*, 10·0). Hegedüs records m.p. 170–172° (uncorr.), and 44 per cent yield.

Our carbobenzoxy γ-L-glutamyl hydrazide yielded a benzylidene derivative, m.p. 200–201° (found: C, 62·5; H, 5·7; N, 11·2; $C_{20}H_{21}O_5N_3$ requires: C, 62·64; H, 5·52; N, 10·96 per cent). Conversion to the azide and coupling with glycine ethyl ester in chloroform solution gave carbobenzoxy γ-L-

glutamyl glycine ethyl ester, m.p. 107–109°, which was saponified to carbobenzoxy γ-L-glutamyl glycine, m.p. 159–161° (found: C, 53·5; H, 5·3; N, 8·3; $C_{18}H_{18}O_7N_2$ requires: C, 53·24; H, 5·37; N, 8·28 per cent). Hydrogenation gave γ-L-glutamyl glycine, m.p. 193–194° (found: C, 41·5; H, 5·9; N, 13·7; $C_7H_{12}O_5N_2$ requires: C, 41·17, H, 5·93; N, 13·72 per cent. $[\alpha]_D^{14} + 11·1° \pm 0·8°$ in water, *c*, 2·5).

Partition chromatography on paper (using phenol saturated with water as the mobile phase) confirmed the purity of the γ-L-glutamyl glycine, in so far as only one component was revealed by ninhydrin. With the latter reagent at *p*H 2·5 and 100°, 1·0 mole of carbon dioxide was evolved, confirming the presence of a free α-amino-acid group.

These investigations are being continued and extended to the aspartic acid analogues. We are grateful to the Government Grants Committee of the Royal Society for financial assistance.

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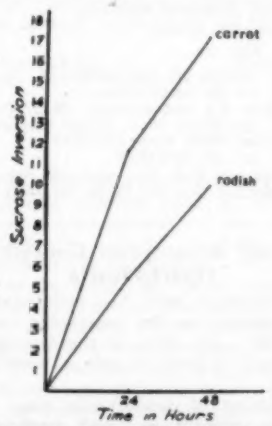
Comparative Study of Sucrose Inversion and Synthesis by Carrot and Radish Root Slices

In previous papers[1,2], it has been established that when radish or carrot root slices were suspended in sucrose solution, the latter was always inverted in the medium before its absorption by the tissue slices, and the inversion was always faster than the uptake, hence the accumulation of invert sugar in the culture medium. Gawadi[3] and Burström[4] showed that sucrose inversion takes place by means of invertase centres attached to the outer cytoplasmic surfaces of cells of the slices. Saïd[1] found that when slices of varied thicknesses were suspended in sucrose solution, the rate of inversion in the medium was directly proportional to the number of exposed surfaces per mass of tissue slices.



Total sucrose inversion in the culture media of equal numbers of carrot and radish root slices having the same diameter

We carried out several experiments in which 1-mm. thick slices of carrot and radish roots, having the same diameter, were suspended in sucrose solutions. Comparing the rates of sucrose inversion by equivalent numbers of slices of both roots, it was found that the rate of sucrose inversion by carrot slices was always much faster than that by radish slices (see accompanying graph). This observation leads to the conclusion that the number of active invertase centres on the outer cytoplasmic surfaces of radish is less than on equivalent surfaces of carrot.

Analysis of the sugar-fed slices from these two plants showed further that carrot slices always build up sucrose from any absorbed sugar whereas radish slices form but little sucrose from the absorbed sugars, the accumulation being always in the form of hexoses.

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Coagulation of Oxalated Plasma Without Calcium Following Neutralization of Heparin by Toluidine Blue

Under physiological conditions, calcium is necessary for the coagulation of blood, because with thromboplastin it brings about the change of prothrombin into thrombin. But the true role of calcium ions has not hitherto been understood. On the other hand, this change is inhibited by heparin in connexion with a plasmatic co-factor, which was determined as an acid-soluble albumin[1]. The anticoagulating influence of heparin is specifically inhibited by toluidine blue[2]. We have used this property of toluidine blue to examine the function of the heparin which in normal circumstances is present in the blood. The influence of the physiological amount of heparin on blood coagulation is still under discussion. The complex heparin–plasma co-factor inhibits the action of thromboplastin on the change of prothrombin to thrombin[3]. We are putting forward the working hypothesis that the interaction between the heparin complex and thromboplastin of plasma is the cause of the fluidity of blood in the vessels, and that calcium in some way either with a tissue extract or otherwise neutralizes the heparin complex. If this assumption is correct, the toluidine blue will coagulate the decalcified plasma.

Oxalated pig plasma was used, and the point of coagulation determined in a water bath at 37° C. Toluidine blue was added in the isotonic Michaelis veronal buffer with sodium chloride in various concentrations. Fig. 1 shows the rate of coagulation of plasma induced by toluidine blue without recalcification. Further, we found that the clotting time under the influence of toluidine blue (curve *A*, Fig. 2) depends on the dilution of the plasma in a similar

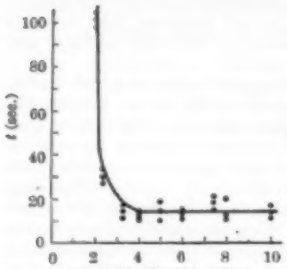

Fig. 1

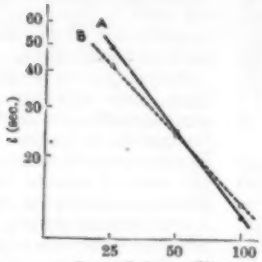

Fig. 2

proportion as in the case of the coagulation with thromboplastin and calcium (curve *B*, Fig. 2).

These experiments show that it is possible to produce coagulation of decalcified plasma without addition of calcium by adding toluidine blue only. The preformed plasma–thromboplastin is active enough to produce coagulation of the blood if the action of the heparin complex is inhibited by toluidine blue. The heparin present in blood takes part also in the blood-clotting process, and the role of that physiological amount of heparin seems to be to maintain the fluidity of blood in the vessels.

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Nature of a Muscle-Inhibiting Compound in Lucerne and its Possible Connexion with Bloat in Cattle

IN an earlier note[1] attention was directed to the muscle-inhibiting power of clover juice and a possible relationship between this action and the disturbance known as bloat, or hoven, in cattle. Further work on a variety of herbage plant juices has confirmed the early findings[2], and has led to the separation from lucerne juice, purification and probable chemical identification, of a substance capable of inhibiting muscle movement.

Hydrocyanic acid can cause smooth muscle paralysis, and undoubtedly some acid is produced in the rumen of cattle grazing legumes, by the hydrolysis of cyanogenetic glycosides. South African workers[3], however, failed to incriminate hydrocyanic acid as a cause of acute bloat, but it should not be ruled out as one of possibly several aggravating or supplementing factors. This aspect has received attention at Aberystwyth[4].

The compound we have isolated from lucerne, by ether extraction of clarified juice, is a pale-yellow crystalline substance which, after repeated crystallization, strongly inhibits muscle action. Chemical and physical examination has shown it to be a flavone, and, subject to final confirmation by synthesis, it is most probably 3′, 4′, 5 trihydroxy, 7 methoxy flavone, a compound which, so far as is known, has not been previously reported as occurring naturally, although Kostanecki[5] synthesized it by reduction of tetramethoxy luteolin.

Flavones occur widely in plant material, presumably as glycosides, and quercetin, 3′, 4′, 5, 7 tetrahydroxy flavanol, for example, has been reported in white clover. Probably species and growing conditions determine the nature and quantity of the flavone present. Although a quantitative separation of the lucerne flavone could not be effected, there was little doubt that the young third-growth in August contained much less flavone than material grown earlier in the year.

Isolated muscle tests were made on thirty-four flavanoid compounds, most of them kindly supplied by Sir Robert Robinson. These all showed muscle-inhibiting action in concentrations between 1/200,000 and 1/50,000. The influence of various substituent groups in the flavone molecule could not be judged with any reliability, since varying, and generally slight, solubility affected the results.

Our knowledge of the pharmacological actions of the flavones is not extensive. They are reported as diuretics, cardiac stimulants and vaso-constrictors[6], and do not appear to be toxic. Their power to inhibit activity of isolated smooth muscle has been noted by Mahal[7]. They exhibit vitamin P-like activity, and rutin, a quercetin-rhamnoside, is being used therapeutically to decrease capillary fragility. The anti-oxidant action of vitamin P-like compounds towards adrenaline, which results in prolonged adrenaline effects on smooth muscle, have been confirmed with rutin, quercetin and the lucerne flavone, the rutin proving far less active than the flavones.

The significance, if any, of vitamin P in ruminant nutrition awaits elucidation, as also does the possibility of flavones playing some part in bloat. Some preliminary tests have been made on sheep, feeding a flavone with and without potassium cyanide. Nothing of note has been achieved in these tests, apart from some inhibition of rumen movements by the cyanide. One difficulty complicating these tests has been the relative insolubility of the flavone. However, the trials will be repeated in the spring when the animals are grazing and ruminant conditions more closely approach those obtaining when bloat occurs.

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Myosin and Actomyosin Content of the Heart-Muscle

SZENT-GYÖRGYI[1-3] and his collaborators began their investigations on the contractile substances of muscle in 1941; my work on the myosin and actomyosin content of heart-muscle is mainly based on their results.

The extraction of actomyosin was carried out following the slightly modified method described by A. Csapó[4]. Pigs and rabbits were employed

as experimental animals. The animal was bled to death, its heart taken out and cooled to − 12° C. The further experiments were performed in the cold room, at 0° C. Two 2-gm. portions of muscle were excised from the frozen right and left ventricle as well as from the auricle respectively; each specimen was ground in a mortar with 6-ml. Edsall's salt solution and sea-sand to a smooth paste. The actomyosin solution was centrifuged, decanted and allowed to stand for 24 hours at 0° C.; then its viscosity was estimated. The measurement was effected in the Ostwald viscosimeter at 0° C., the actomyosin solution having first been diluted with 9 volumes of *p*H7 veronal–acetate buffer. The viscosity of the actomyosin solution being thus determined, 0·1 ml. of 12 mgm./ml. adenosinetriphosphate solution was added, and then its viscosity measured again. From these two viscosities the myosin content and myosin–actin ratio was calculated, according to Straub and Balenovic. This ratio is expressed as a 'per cent activity' as Straub suggested. The myosin content, and the actin–myosin ratio of 1 ml. of an actomyosin solution extracted as described above, are given in the accompanying table.

	Left ventricle		Right ventricle		Auricle	
No.	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin
1	156	11·5	112	11·0	74	8·5
2	170	9·5	100	11·5	74	8·5
3	179	9·5	120	9·8	110	7·8
4	162	11·0	124	11·0	87	8·5
5	164	11·0	130	10·5	113	8·0
6	180	10·5	122	10·0	97	8·0
7	130	10·0	78	10·0	65	8·0

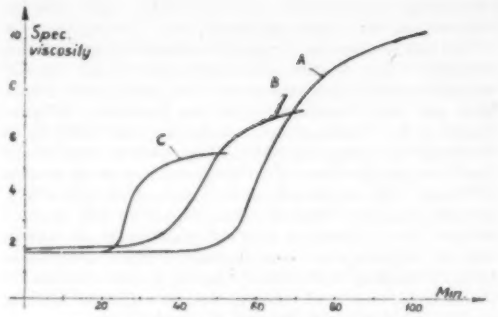
The values obtained, estimated by R. A. Fisher's method[5], give the following results. Average value of the differences between the myosin extracted from the ventricles and auricle respectively: $\bar{x} = 2·3$; t (Student) $= 116·0$; $P \ll 0·001$. Average value of differences between the actin–myosin ratio of the right and left ventricle (expressed as 'per cent activity'): $\bar{x} = 50·7$; $t = 10·5$; $P \ll 0·001$. The average value of differences between the actin–myosin ratio of the right ventricle and the auricle: $\bar{x} = 24·0$; $t = 5·75$; $P \ll 0·001$. Since the P's are much less than 0·05, the lowest limit accepted in medical work, these three differences may be considered as statistically significant.

Experiments carried out on rabbit heart, expressed in the same manner, show the following values:

	Left ventricle		Right ventricle	
No.	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin
1	90	7·0	55	6·8
2	160	9·0	64	8·8
3	120	8·0	56	8·8
4	140	8·0	77	7·8

Proceeding in the same manner as described above, we find that the average value of differences between the actin–myosin ratio of the right and the left ventricle is: $\bar{x} = 64·5$; $t = 5·28$; $P \ll 0·001$. Thus the difference is significant.

My further investigations were extended to a modified Couette (torsion) viscosimeter also. The method was as follows. The actomyosin solution (prepared as described above) obtained from the left ventricle, right ventricle and the auricle of pig's heart was diluted with Edsall solution to about twice its volume, in order to have the same starting concentrations of myosin. The increase of viscosity, caused by the splitting of adenosine triphosphate, was



A = left ventricle; *B* = right ventricle; *C* = auricle

recorded by the Couette viscosimeter, kept by a Hoeppler ultrathermostat constantly at 24° C. exactly. The values thus obtained are given in the accompanying curve. Specific viscosity is plotted against time.

The results show that there is a difference as regards the contractile proteins between auricle and ventricles, as well as between right ventricle and left ventricle. If we excise the same amount of muscle from the auricle as from the ventricles, we can extract less myosin from the auricle than from the ventricles. The left ventricle, accomplishing most of the work, contains more actin than the right one. The auricles, which do only regulating work, contain less actin than the ventricles.

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Effect of 'Gammexane' on the Durability of Paper

The use of 'Gammexane' has been recommended for controlling insect pests in libraries and record offices, where insect infestation is a serious problem especially in a tropical climate. 'Gammexane' smoke generators appeared to be particularly suitable for this purpose owing to the ease and safety with which they can be handled. But no information about its effect on paper[1] was available, and the use of a new insecticide for the disinfestation of documents of a unique and irreplaceable nature had therefore to be scrutinized from the preservation point of view.

No. 2 'Gammexane' smoke generators, weighing approximately 2 oz. each, were used at a concentration of 2 oz. per 1,000 cu. ft. as recommended by the manufacturers, Imperial Chemical Industries, Ltd., for insects infesting stored products. Samples of paper were exposed to the smoke for 72 hours in order to allow it to settle down completely, and care was taken to prevent any scorching effect from the smoke generator. Samples exposed to 'Gammexane' smoke were also submitted to accelerated ageing, which consisted in heating the samples for 72 hours at 100° C. The tensile breaking strength and the folding endurance of the treated and control samples were measured according to the standard TAPPI

(Technical Association of the Pulp and Paper Industry, New York) methods.

The mere exposure of paper to 'Gammexane' smoke brought about a substantial decrease in its tensile strength and folding endurance—as much as 53·7 and 71·5 per cent respectively in one instance. Papers exposed to 'Gammexane' and then submitted to accelerated ageing turned slightly yellow, and there was a complete loss of folding endurance in nearly all cases. All-rag hand-made paper of an extremely durable quality used for the repair of old manuscripts had a normal folding endurance of 4,164; but on exposure to 'Gammexane' smoke the retention of folding endurance was 28·5 per cent only, while on accelerated ageing the retention of folding endurance further decreased to zero.

The data obtained conclusively prove that treatment with the No. 2 'Gammexane' smoke generator is definitely injurious to paper records of all kinds and affects their durability as badly as acidic gases[1]. As the water through which the smoke had been bubbled was found to be distinctly acidic, it is almost certain that at least a part of the embrittling effect produced on paper[2] is due to the smoke-generating materials rather than to the 'Gammexane' itself. However, the gases obtained from the smoke generator No. 2 has a deleterious effect on paper, and it is advisable to prevent it coming into direct contact with paper records and manuscripts intended for permanent preservation.

The investigation is being followed up, and the details will be published in a subsequent issue of the *Indian Archives*.

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Zoosporangia, believed to be those of *Plasmodiophora brassicæ*, in the Root Hairs of Non-cruciferous Plants

IN 1936, during work on the cytology of *P. brassicæ*, zoosporangia identical with those of this well-known parasite were seen by me in root hairs of grass and dock seedlings, which had appeared in a pot of soil taken from a garden in which the club root disease of the Cruciferæ was a major problem. In view of the known persistence of *P. brassicæ* in soils without cruciferous crops, it was decided to attempt a crude cross-inoculation experiment using club root galls as a starting point. Suitable soil was partially sterilized by keeping it at 190° F. for one hour. Ten six-inch pots were filled with this soil, and club root galls with unbroken surfaces, but of an age known to contain mature spore masses, were cut up and placed in five of them. Brussels sprout seedlings germinated in these pots became infected, and an examination of the root hairs of the grass *Holcus lanatus* grown from seed with them in the re-infected soil revealed numerous zoosporangia and some free-swimming zoospores.

Twenty of these root hairs, which were, so far as could be seen, free from external debris of any kind, were placed in three of the remaining five pots of sterile soil, in which seedlings of brussels sprout were growing. In these three pots, ten of the twelve seedlings became infected, apparently with *P. brassicæ*, while in the two control pots the eight plants remained free from attack.

The root hairs were removed from the *Holcus* plants, after careful washing in distilled water, by sucking the end of the hair into a capillary of suitable size and gently tearing away the required portion. This was done without the aid of a micro-manipulation apparatus, and it is fully realized that it would have been preferable to transfer zoosporangia or zoospores alone. This was, however, not possible. The cycle of events in zoospore formation in root hairs appears to be identical, up to the point at which zoospore formation begins, with the normal cycle in cruciferous roots. The somatic mitoses, transitional phase and reduction division were all seen and were similar to those described for *Spongospora subterranea* by Horne[1] and for *Sorosphæra veronicæ* by Webb[2].

In July 1948 similar zoosporangia were seen by me in two root hairs of 'Auchincruive Climax' strawberry from Botley, Hampshire. Subsequent inquiry revealed that club root had been troublesome in the immediate vicinity.

Plasmodiophora brassicæ has been suspected of infecting plants other than the Cruciferæ on several occasions in the past, notably by Marchand[3] in 1910. The hypertrophy described in these accounts of the disease is now usually ascribed to nematodes, and reports of the presence of the *Plasmodiophora* are treated with great reserve. Marchand[3] saw what he believed to be *Plasmodiophora* in melon, celery and "oseille-epinard", which latter is believed to be a dock, *R. patientia*; but the spore diameter in melon was twice that of *P. brassicæ* in crucifers, and the identity of the parasite is thus open to doubt.

In view of the present methods of control of club root, it is highly desirable that the identity of the zoosporangia I have seen, and the specificity of *P. brassicæ*, should be established by cross-inoculation experiments using all possible precautions to ensure sterility.

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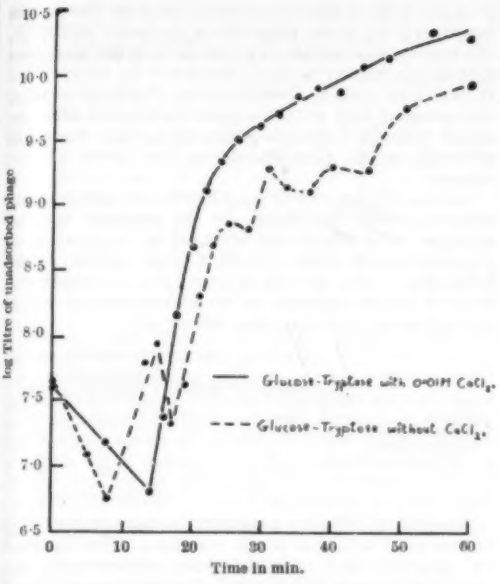
Multiplication of Coliphage at High Concentration

THE 'single-step' method devised by Ellis and Delbrück[1] has proved of immense value in the hands of a number of workers in studying the multiplication of various bacteriophages; but it was devised specifically to investigate the behaviour of bacteria and adsorbed phage at high dilution, and gives no direct information about the more complex situation normally occurring, when phage released by lysis of one bacterium can interact further with other bacteria. Since this information was necessary for a line of investigation we are pursuing, and since, moreover, it might prove of more general interest, we have devised the method described below.

Escherichia coli, strain *B*, is grown in a medium consisting of 2 per cent Bacto Tryptose, 0·2 per cent glucose and 0·5 per cent sodium chloride for 2½ hours at 37° C., by which time the viable count is 50–70



million organisms per ml. Coliphage T_2 is then added to produce a final concentration of about fifty million lytic units per ml., and aliquots removed at intervals for assay. These are diluted several hundred times into 0·85 per cent saline containing 0·01 *M* phosphate buffer, *p*H 7·0, maintained in an ice-water bath (slow release of phage from the bacteria occurs at room temperature), and then the diluted mixture centrifuged in an angle centrifuge at 3,500 r.p.m. for 10 min. to remove bacteria and adsorbed phage. An aliquot of the supernatant is further diluted in phosphate-saline and assayed by the plaque-counting method of Hershey, Kalmanson and Bronfenbrenner[3]. From these estimations a curve is obtained giving the titres of unadsorbed phage in the original mixture at various times.

An example of the application of the method is given in the accompanying graph, which illustrates preliminary experiments on the effect of calcium ions on the release of phage from the bacteria. Calcium is known to have a marked effect on the multiplication and plaque formation of phages[3,4,5], but no attempt seems to have been made previously to follow the course of adsorption and lysis in its presence. As the graph shows, 0·01 *M* calcium chloride causes a marked alteration in the form of the curve: in the ordinary medium, multiplication of phage proceeds in a series of stages of adsorption and release, each stage occupying the same time for all bacteria infected simultaneously, so that the graph shows a series of sharp peaks and hollows; in contrast, release of phage and re-infection of further bacteria in the presence of calcium appears to occur in random fashion after the initial adsorption period, the multiplication appearing as a smooth increase in the titre of unadsorbed phage. A number of other points of interest also emerge from these experiments: (1) both in the presence and in the absence of calcium, adsorption of phage on to the bacteria continues logarithmically up to the time when lysis begins; (2) the latent period before lysis commences is lengthened from 8 min. to 14 min. in the presence of calcium; (3) while the experimental curves for adsorption and lysis in the presence of calcium are readily reproducible in other experiments, in its absence only the points of inflexion at 8–9 min., 15–16 min. and 17–19 min. can be reproduced, the later stages being extremely variable; (4) the final titre at 60 min. is invariably higher in the presence of calcium; and (5) the turbidity of the culture is always greater after lysis with calcium in the medium.

The significance of these findings, taken in isolation, is not clear. But the results of other experiments (to be published later) on the effect of enzyme inhibitors on phage multiplication indicate that the calcium ions also probably have an inhibitory effect on one of the enzyme systems of the bacteria.

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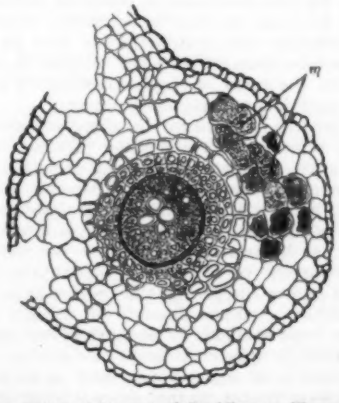
Occurrence of Endotrophic Mycorrhiza in the Roots of *Pteridium aquilinum* Kuhn.

Although Stahl[1] believed that *Pteridium aquilinum* was one of the completely autotrophic ferns, later workers[2–5] have reported the presence of an endotrophic mycorrhiza, and Truszkowska[5] described an endotrophic mycorrhiza in the roots of *Pteridium aquilinum* in Poland which he found growing in soil of *p*H 4·4.

A mycorrhizal condition in roots of bracken in Scotland was demonstrated by Alcock in 1927[2]. Recently, it has been found in two areas in the west of Scotland, where (as Alcock had previously found) it seems to occur irregularly, but possibly more often than was at first realized. The two areas are: (*a*) Drumclog Moor, Milngavie, Dumbartonshire, where roots with mycorrhiza were found in March, April, May and July. The soil was peaty with much humus and had a *p*H of 4·4, a point that agrees with



Transverse section of the root of *Pteridium aquilinum* showing the mycorrhizal layers of cells in the middle cortex. (Camera lucida drawing, × 55)

Truskowska's observations. (*b*) Horticultural land near Auchincruive, Ayr, where roots with mycorrhiza were found in July. The soil was a loam of *p*H 7·7.

Many of the roots of *Pteridium aquilinum* in both these areas were quite unaffected; but those with mycorrhiza were rather fleshy and larger than the others. These features were by no means regular and were not an infallible guide to the presence of the fungus. It has not been seen in the roots of young plants, but such young roots as have been examined were those of cultivated plants.

The accompanying drawing shows the endotrophic mycorrhiza occurring irregularly in the cortical cells of the root. In some cases, the apices of the hyphæ showed small swellings which may be similar to the 'sporangioles' mentioned by McLennan[3]. The fungus was found in the middle cortex, and the thickened cells of the inner cortex showed little infection. It has been seen in several layers of cells and not confined to one cortical layer as described by Rayner for *Aspidium filix-mas*[3]. No special digestive zone could be distinguished.

It is probable that the presence of such an endotrophic mycorrhiza is more widely spread among bracken plants than is at present appreciated.

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Effect of Sulphanilamide and *p*-Aminobenzoic Acid on Mitosis

THE action of sulphanilamide on plant growth shows many parallels to its action on bacterial growth. As Bonner[1], and more recently Audus and Quastel[2], have shown, sulphanilamide will completely abolish growth in length or wet-weight of roots. This inhibition, as in bacteria, is competitively reversed by addition of *p*-aminobenzoic acid to the nutrient solution. Audus and Quastel, however, are of the opinion that the competitive reversal is of a different nature in root growth from that in bacterial growth. Their evidence for this statement is based on the fact that, while in bacteria reversal is complete even with a *p*-aminobenzoic acid concentration 1/50 to 1/4,000 that of sulphanilamide, in roots reversal is complete only when the ratio of sulphanilamide to *p*-aminobenzoic acid is approximately unity.

Plant growth as measured in these experiments is, however, a rather more complex process than bacterial growth, in that the bulk of growth in length or wet-weight is the result of expansion of cells by uptake of water. The amount of 'growth' caused by cell division in the meristems is only a small fraction of the total increase in volume or wet-weight. It seems necessary to attempt a separation of these processes before discussing the mechanism.

The action of sulphanilamide on mitosis in plant cells has been studied by several investigators[3,4,5]. Sulphanilamide appears to have two actions: (1) At concentrations of 0·1–0·5 per cent it stops nuclei coming into prophase, so that there is a fall in number of dividing cells. From experiments on the lateral roots of onion, the number of mitoses is reduced to 0–15 per cent of the original number, after forty-eight hours. (2) In those cells which do begin to divide, the spindle mechanism is upset so that the anaphase movement rarely, if ever, occurs. As Peters[4] has shown, this leads to the formation of tetraploid cells, the arrested cells with scattered metaphase chromosomes without a spindle gradually lapsing back into a resting stage, thus simulating the action of colchicine.

During the last two years, I have been investigating sulphanilamide inhibition, in an attempt to find whether these effects are reversed by application of *p*-aminobenzoic acid. Both effects appear to be reversible. The accompanying table indicates the kind of result obtained in an experiment in which the *p*H of all solutions was about 4·0.

	Prophase	Metaphase	Anaphase Telophase	Total
Control	290	112	113	515
Sulphanilamide	29	9	1	39
Sulphanilamide/ *p*-Aminobenzoic acid	315	58	59	432

Results of different experiments have varied, and the reversal is not as a rule complete. The numbers for anaphase and telophase have always been less than in the controls, although the divisions which do occur seem to be normal.

In preliminary experiments on the effect of *p*H on reversal, it has been found that at *p*H 7·0 reversal is far less complete than at *p*H 4·0. Possibly this is simply due to ionization and permeability effects, and the different results obtained with bacteria and higher plants may be due to such relationships.

I wish to express my thanks to Prof. A. Burges and Prof. H. N. Barber for advice.

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Occurrence of *Acanthocephalus ranæ* Schrank in Great Britain

RECENTLY, Dales[1] and Eales[2] recorded the occurrence of *Acanthocephalus ranæ* Schrank in Great Britain. Three specimens of this species were discovered during routine dissection of *Rana t. temporaria* L. this session, and a further eight specimens in the departmental collection have been examined. Of the latter, seven were taken from *Bufo b. bufo* (L.) and one from *R. t. temporaria*. A summary of the ten specimens is given in the accompanying table.

The numbers of rows of hooks and number of hooks per row were counted after making camera lucida drawings. As the proboscis was not fully extended in all the specimens, it was not always possible to be absolutely certain about the numbers.

In this Department, an average of twenty-four *R. temporaria* were carefully examined each year from 1927 until 1939 for metazoan parasites. During that time only one *A. ranæ* was found. Further, one of us (H. R. H.) examined the gut of several hundred *R. temporaria* of British origin (exact locality unknown) during the years 1922–24. No specimens of

Number of longitudinal rows of hooks	Number of hooks per row	Total length in mm.	Sex	Host	Locality	Remarks
—	—	approx. 5	♀	*Rana t. temporaria*	Norwich, Norfolk	Specimen lost before detailed examination. Collected Dec. 1948
12	6	5	♀ (gravid)	,,	,,	Collected Dec. 1948
14	6	5	♂	,,	,,	Collected Oct. 1948
13	6	4·5	♂	*Bufo b. bufo*	Amersham, Bucks	
14	6	4·5	♂	,,	,,	
14	5	2·5	♂	,,	,,	Toads collected by Lancelot Hogben, Oct. 1921.
14	5	5	♀ (gravid)	,,	,,	
14	5	3	♀ (gravid)	,,	,,	Specimens of *A. ranæ* prepared by H. R. Hewer when a student
14	5	3	♂	,,	,,	
14	5	2·5	♂	,,	,,	
12	5	4	♂	*Rana t. temporaria*	Newdigate, Surrey	Collected Oct. 1930

A. ranæ were found, although many contained numerous other helminth parasites.

All the specimens recorded above are comparatively short. The samples from *R. temporaria* are too small to be significant. Those recorded from *B. bufo* were not the only specimens found on that occasion. Two or three other members of the class each found a similar number of specimens, all of which were of about the same size. It is possible that *A. ranæ* does not reach the same large size in *B. bufo* as it does in *R. temporaria*.

It appears probable that the distribution of *A. ranæ* in Britain is local; but that where it is found it may be abundant. Obviously, Dales is correct in suggesting that its apparent rarity is due to lack of recorded observations.

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Nomenclature of Polymyxin Antibiotics

Polymyxin is a term introduced by Stansly, Shepherd and White[1] for an antibiotic substance elaborated by *Bacillus polymyxa*.

Brownlee and his colleagues[2,3] independently reported the discovery, from a different strain of *Bacillus polymyxa*, of an antibiotic designated as 'Aerosporin' which appeared to be similar to 'polymyxin' in its antibacterial spectrum, but to exhibit certain different pharmacological properties[3]. Evidence has recently been obtained[4,5] which confirms that 'polymyxin' differs from 'Aerosporin' both pharmacologically[6,7] and chemically[4,5]. Furthermore, it is now known that different strains of *Bacillus polymyxa* are capable of producing a number of related antibacterial substances which differ chemically[4,5] and pharmacologically[6,7] one from the other.

In view of these circumstances, it appeared advisable to unify the nomenclature of this group of antibiotics in order to emphasize the relationship of the members of the group and to avoid the publication of an array of bizarre names which would only confuse it. This end has been achieved by agreement on 'polymyxin' as the generic term for these antibiotics, the individual members being polymyxin A, B, C, D, etc.

At the present time the known polymyxins may be characterized as basic antibacterial polypeptides, the salts of which are water-soluble, having a unique specificity for the Gram-negative bacteria. The known members have, in common, α,γ-diaminobutyric acid, threonine and a branched C_8-fatty acid as molecular constituents[4,10].

Polymyxin A is the name given to 'Aerosporin'[2]; in addition to L-threonine and L-α,γ-diaminobutyric acid, it contains D-leucine[10]. Polymyxin B contains both leucine and phenylalanine as additional constituents, whereas polymyxin C contains only one additional amino-acid, namely, phenylalanine[5]. Polymyxins B, C and E, the product of distinctive strains of *Bacillus polymyxa*, have recently been announced from the Wellcome Research Laboratories[5,8]. Polymyxin D is the main active component of the material described from the American Cyanamid Company[1,4,11] and contains D-leucine and D-serine in addition to the common constituents[4,5]. Polymyxin E contains the same constituents as polymyxin A, but is distinguished from the latter by partition chromatography on paper[8]. The fatty acid of the polymyxins has been described but not fully characterized. It appears to be the same in polymyxins A, B and D[4,10].

Attention is directed to the fact that no implication of priority is to be attached to the sequential assignment of letters. Assignment of letters to further antibiotics in the series should be based solely on published data which characterize the antibiotic as a new member of the polymyxin group.

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AIR SAFETY

IT is a maxim of aircraft design and operation that economics and safety are complementary factors, and that it is always possible to achieve a favourable financial return by ignoring safety considerations, whereas too great a concentration on safety tends to result in economic failure. It is in the achievement of a fine balance of the two factors that the skill and ability of the efficient designer and operator manifest themselves.

This maxim was, no doubt, very much in mind, although never stated, at the all-day discussion on air safety held by the Royal Aeronautical Society on March 5 at the Institution of Civil Engineers. Four papers were presented covering different aspects of the problem, but few significant advances of scientific interest were revealed.

The first paper, by Mr. J. D. North, was on "Some Aspects of the Relationship between Airworthiness and Safety". In this paper, Mr. North brought some of the concepts of philosophy and psychology to bear on the problem. Starting with the conception of 'net yield' (being the difference between 'gross' yield and a somewhat indeterminate quantity 'damage'), he analysed the factors involved in the various terms, the principal ones being the environment, the human factor and the type of aircraft. The method of analogy provided the main approach, and his analogy was that of a game having the nature of patience or solitaire, the object of the game being to move along a grid containing several hazards and to lose the minimum number of points, the optimum path representing the time–space motion which gave the minimum damage. Statistically there is no doubt some basis for such an analogy; but the discussion indicated a certain lack of appreciation of Mr. North's methods and objectives. Apart from criticism of the vagueness of the term 'damage'—which, when interpreted as loss in prestige as well as material loss, may well alter the framing of the initial concept—one of the chief objections to the analogy is that it is unnecessary to import into the science of aeronautics unfamiliar methods and notations which lead eventually to results derivable far more simply by the usual methods. Indeed, there was great doubt as to whether more than a tiny percentage of those present at the discussion understood Mr. North's paper.

The second paper, on "The Physiological Aspects of Air Safety", was read by Dr. K. G. Bergin. The advances in the field of aviation medicine at the present time are naturally associated with the advances of aviation generally. Particular points of interest are the effects of high accelerations and decelerations, high-altitude effects, low-temperature effects, effect of vibrations, and the toxic effects of fumes. All these are, however, problems which arise principally in military aircraft, and so it was a much more restricted field of rather less interest that was covered by Dr. Bergin, who dealt with questions occurring during normal civil operations.

Referring to the question of vision, Dr. Bergin stated that the average percentage decrease in range of night vision varies linearly with altitude, being 5 per cent at 4,000 ft. and 35 per cent at 16,000 ft. Other factors reducing night vision include glare, lack of oxygen, smoking, alcohol, inadequate vitamin A, and fatigue. Suitable precautions can always be taken to ensure that diminution in visual acuity is not dangerous, particularly since the effect is temporary. A more serious problem is the permanent and irreversible deterioration in hearing, known as aviation deafness, resulting from the constant bombardment of the ear by noise over a period of time. The trouble is progressive, starting with a reduction of auditory acuity over the high-frequency range and eventually including the low tones as well. Lack of oxygen is a great potential source of accidents, since it results in false impressions of the pilot's own capabilities, a diminution in skill, speed of reaction and accuracy of attention to detail. The vision is also affected, particularly the power of accurate focusing and optical convergence.

On the question of equilibrium, Dr. Bergin described three common disorders: the auto-kinetic illusion, the oculo-gyral illusion possibly complicated by autokinesis, and the oculo-gravic illusion. The first of these consists of the apparent movement of an object when viewed against a dark background in the absence of spatial localization. The condition is dangerous only if it occurs at a critical moment. The second illusion is due to conflicting impulses from the eye and the semi-circular canals in the part of the ear known as the labyrinth, which, following angular acceleration, results in the apparent movement of objects. The third illusion is due to conflicting impressions between the eye and the otolith organ, and, following accelerations, consists of an apparent displacement of an object in space. The effect of the illusions can be eliminated by blinking, by the use of flashing lights instead of steady lights, or by the use of a number of non-planar lights.

The elimination of fatigue of personnel is important in accident prevention, since fatigue can result in diminished nervous impulses, slowed reactions, impairment of judgment, vision and hearing. Dr. Bergin emphasized the necessity for proper rest for the pilot between flights, adequate diet, and good conditions inside the cockpit. The latter should include proper seating, good windshield design, correct positioning of the instruments and controls, and good insulation. By great care of the health of the crew the risk of accidents can be diminished, and thus the medical aspects of aviation are of fundamental importance.

The third paper, by Capt. J. W. G. James, was entitled "Air Safety from the Pilot's Point of View". His paper was, of necessity, more concerned with the human element than with a scientific approach. He dealt with most of the current difficulties encountered by pilots, in particular stressing the need for better control-cabin layout and good handling characteristics (involving light controls, rapid response, low safety speed, stability, and no change in longitudinal trim during flap and undercarriage movement). The importance of proper training for pilots in order to achieve a high standard of technique, particularly in instrument flying, cannot be over-stressed, and Capt. James expressed very definite views on this point. He also advocated the use of a medical service for maintaining health—as distinct from its use as an examining body—which at the moment is the function of the Ministry's medical service. He was somewhat critical of the present conception of 'flying hours' as a criterion for pilots' efforts, and suggested that an 'hours on duty' restriction may eventually be introduced. He felt, however, that all restrictions of this type could be

more easily handled by the co-operative effort of the pilots and operators. On the question of operating technique, Capt. James laid down recommended procedures and suggested that the use of drill cards for checking their implementation is desirable. The procedures, although of interest and conducive to increased passenger comfort, would not seem to increase the inherent safety of operation. He deplored the lack of standardization of air traffic control systems—some five are in common use—and expressed the view that such variations tend to decrease safety owing to the excessive practice required to maintain efficiency. The subject of accident investigation—about which much was said in the later discussion—has always been of particular interest to pilots, and Capt. James stressed the importance of this, since only by adequate representation of pilots on investigating committees can the stigma of pilot's error be avoided. (A rather interesting point raised in the course of the discussion was that the term 'pilot's error' might well be replaced by 'designer's error', since the possibility of guarding against possible mistakes in operation can well be regarded as the designer's responsibility.)

The last paper, presented by Dr. G. E. Bell, was entitled "Operational Research into Air Traffic Control". This paper was concerned with experimental investigations (including time and motion studies of take-off and landing, studies of air/ground communications, and an analysis of the traffic and traffic pattern in south-eastern England) and with theoretical investigations into the problem of traffic congestion. The quantitative data on the distribution of delay times was extremely enlightening. In August 1948, at London Airport, about 40 per cent of the incoming aircraft were held for an average time of rather less than 10 min., the average holding-time for all aircraft being some 3½ min. At Northolt, where the loading is heavier, the corresponding figures are 65 per cent held for an average of 16½ min. with an overall average of 10½ min. Approach times vary between 6 and 15 minutes, whereas runways are occupied for between 8 and 9½ minutes for each landing. Thus landing delays are considerable, and the necessary stacking increases the risk of collisions. Dr. Bell presented an analysis of the traffic congestion problem on the assumption of a constant holding-time and based on considerations of statistical equilibrium. He showed that by a knowledge of the 'expectancy' ϵ, or average number of arrivals in the holding time T, and of the values of the arrival probabilities, the probable degrees of congestion can be estimated. Assuming the Poisson distribution of probabilities, the mean delay is given by

$$t = \tfrac{1}{2}\,\frac{\epsilon}{1-\epsilon}\,T.$$

The effect of deviations from stipulated fixed intervals of arrival was also considered, and it was found that the improvement of a scheduled arrival-rate over a random one is only marked when the standard deviation is small compared to the scheduled interval.

He concluded by pointing out that the capacity of an airport is seriously affected by the 'holding time'; thus at a factor of 0·8, a 10 per cent reduction in holding time increases the capacity and reduces the average delay for the same congestion by some 10 per cent. The most promising approach to reduced holding times is the greater use of radar control.

Much can be said of the value of the day's discussion, but undoubtedly the contribution to the subject of 'air safety' was very limited. Too many gaps were left to regard the meeting as satisfactory. The attitude of the designers and the official regulating body (the Air Registration Board) only slipped in during the general discussion following the papers, instead of being adequately covered by formal statements; and it is a great pity that too much time was spent by the principal speakers on matters outside the scope of the day's proceedings, and too little on the fundamental requirements for an improvement of 'air safety'.

HENRY ROBERTS

BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

THE British Hydromechanics Research Association was officially incorporated on September 20, 1947, as a company limited by guarantee, and at the first annual general meeting held a month later Sir John Anderson was appointed president, and a council of ten elected. In the Association's first annual report, which has recently been issued, a review is given of the progress during the period October 1947–September 1948. Mr. L. E. Prosser was appointed director of research in April 1948, and a small staff was recruited later in the year. Thirty-one manufacturers of hydraulic and related machinery are members of the Association, and the associate members include twelve firms of consultants and twenty professors and academic workers. Although directly controlled by industry, the Association operates under the ægis of the Department of Scientific and Industrial Research, and it is hoped that, in the very near future, with adequate support forthcoming from industry, the Association will qualify for a Government grant.

The aim of the Association is to promote original research in hydraulics, and in the application of scientific principles to the manufacture and use of hydraulic machinery and equipment. In this connexion it acts as a liaison between industry and university and Government research laboratories. An efficient information service is being built up to collect and disseminate to the members technical information on hydromechanics and related topics. There is a need for an abstract service covering current publications on hydraulic science, and the *Bulletin* of the Association should prove very valuable in this respect. The first number of the *Bulletin* appeared at the end of 1948, and its contents include a selection of non-critical abstracts arranged in accordance with the universal decimal classification, Association news, and book reviews.

Six sectional research committees, dealing with fundamental fluid mechanics, measurement and laboratory technique, pumps and turbines, control and motion of fluids in pipes and valves, seals and joints, and reciprocating machinery, have been set up. The names of the members of these committees and the subjects under consideration are listed in the annual report. There is little doubt that the Association can become invaluable to the hydraulic industry of Great Britain, and, as Sir John Anderson points out in his foreword to the report, "the formation of this new Research Association is more significant than its present modest development would indicate, as it represents a further step towards a closer relationship between Government and technical interests of industry".

TEMPERATURE MEASUREMENTS IN ECOLOGICAL ENTOMOLOGY

By W. G. WELLINGTON
Forest Insect Laboratory, Sault Ste. Marie, Ontario

MUCH research in ecological entomology is concerned with the effects of temperature upon insects. Nevertheless, there is still some dissatisfaction with instruments or methods employed to measure temperatures for entomological purposes. Difficulties are often encountered in projecting laboratory data to field situations, or in attempting to reverse this procedure, and it is admitted that the numerous special methods for registering air temperature outside standard shelters yield figures which are, for some purposes, no more closely associated with an actual habitat than are shelter temperatures.

It is known that the marked differences observed between the temperature of the air and that of individual parts of both plants[1–3] and insects[4–7] result from radiant heating or cooling as well as from moisture transfers. At least so far as radiant heating is concerned, the temperature differences produced may be so large that, when they occur, continuous records of air temperature are of little value for connecting the results of laboratory and field observations. Thus, it seems time to pay some attention to means of obtaining more useful temperature records.

Such temperature differences as have been demonstrated have been measured chiefly by thermoelectric means. However, indicating potentiometers are limited in usefulness by the fact that they give only instantaneous measurements; and, for general field use, there is a great need for simpler and less expensive recording equipment than power-dependent recording potentiometers.

Both the plant habitats of insects and insects themselves behave more or less like black bodies. This being so, it would seem profitable to investigate the uses of thermometric equipment modified so that it may absorb or emit radiation freely. This approach requires some changes in our attitude towards thermometry. Hitherto, although entomologists rejected the instrument-shelter which attempts to standardize radiational errors in temperatures measured for synoptic or climatological purposes, they have assumed the attitude of meteorologists towards the exposure of instruments to radiation. Thermometer bulbs and thermograph bimetals are still shielded or polished 'to minimize undesirable' radiation effects. While there are very sound reasons for this when air temperatures are involved, in situations where plant or insect temperatures may differ by 5–20° C. from ambient temperatures, what is the point of measuring air temperature? It would seem preferable to try to make some of the existing instruments as similar as possible to the natural bodies and to expose them to equivalent conditions. Admittedly, there are some recognized objections to this procedure, which are based on varying heat capacities and on the blunt statements that no measured temperature is what one thinks it is; but the technical difficulties are not insurmountable if thinking is directed along lines differing from the accepted approach. More often than we realize, the chief interest of an ecological entomologist in radiation is in its temperature effects, not in its intensity. Wider recognition of this might diminish the numbers of ingenious adaptations of precision thermopiles and bolometers, from the records of which ecologists laboriously convert the heating or cooling effects of radiation—which are what they need—into units of radiation—which they can seldom apply. Furthermore, to obtain these records, the instruments are carefully shielded from air temperature and movement which act constantly upon the natural 'black bodies'.

Recent tests of a modified thermograph at this Laboratory have shown promise. During tests of the effects of radiant heating upon the foliage of *Abies balsamea* Mill. under field and laboratory conditions, it was noticed that blackened thermocouples or junctions attached to blackened aluminium disks reached the same temperatures as did the interiors of closed or expanded buds, or of enclosed tortricid feeding chambers. On the other hand, these special junctions were better 'black bodies' than the individual needles, but less efficient than staminate flowers. These junctions were matched, and while similar temperatures were recorded at the points noted above, consistent differences were recorded between the flower and vegetative buds and between all foliage and the surrounding air, so that the similarities observed did not result from peculiarities of the junctions. When field observations were extended to other tree species (*Picea glauca* Voss, *P. pungens* Engelm., *Pinus Banksiana* Lamb. and *Populus tremuloides* Michx.), the relationships were found to hold among coniferous species and, while normal aspen leaves were not equivalent to black surfaces, the temperatures of air spaces enclosed by leaves rolled or tied by tortricids were equivalent to those of the surfaces. Finally, the bimetal of a thermograph was blackened and the instrument was exposed beside the trees and the disks. Close agreement was obtained among the temperatures of the buds, shoots, tunnels, disks and bimetal under conditions of uniform exposure. The thermograph pen, of course, often recorded fluctuations amounting to 5° C. in sunlight, but, at such times, the foliage temperatures moved through the lower third of this range very consistently, or, at worst, fell 1° below it momentarily. At the same times, air temperatures ranged up to 6° lower than the foliage. In the absence of fluctuations, foliage and bimetal temperatures were equivalent or within 0·5°, while the air temperature was still too low.

The fact that a black paint ('Drop Black Enamel') chosen at random and applied to a bimetal produced temperatures in far better agreement with bud or enclosed air-space temperatures than were air temperatures, suggests that this approach is worth further investigation by interested workers in a position to test instruments under more varied conditions than are available within the present narrow limits of altitude and latitude. Such tests seem worth while even when it is to be expected that treated bimetals cannot record temperatures similar to those of great numbers of plants or insects since, as noted above, discrepancies appeared in tests of staminate flowers or of individual needles of one species.

During the preliminary tests, at least an indicating potentiometer and thermocouples are essential for establishing the relationships. Any weatherproof thermograph may be used, but the bimetal must be freely exposed. Some workers may prefer models which record at a distance, so that the bulb may be placed in a tree, while the recording mechanism

remains accessible. It should be emphasized that large discrepancies will occur during preliminary comparisons between foliage and thermograph if conditions of exposure are not uniform. A surprisingly small amount of shade, which may not be obvious during casual inspection, will produce differences of 2–3°. Also, exposure to winds should be uniform during the tests.

There is no reason why paints with different absorption bands should not be tested. Moreover, in tests related to broad-leaved plants, it might be advisable to wrap a portion of the bimetal in a moist wick to simulate the effects of transpiration. Actually, the leaves of certain field crops appear to be long enough, so that living leaves might be wrapped around a suitably placed bimetal. Other modifications of existing equipment will occur to the reader interested in obtaining more representative temperature measurements.

[1] Curtis, O. F., *Plant Physiol.*, **11**, 343 (1936).
[2] Curtis, O. F., *ibid.*, 595.
[3] Curtis, O. F., *Amer. J. Bot.*, **25**, 761 (1938).
[4] Gunn, D. L., *Biol. Rev.*, **17**, 293 (1942).
[5] Uvarov, B. P., *Trans. Roy. Ent. Soc. Lond.*, **99**, 1 (1948).
[6] Kirkpatrick, T. W., *Anani Memoirs*, **1** (London, 1935).
[7] Wellington, W. G., *Canad. Ent.* (in the press).

STATE SUPPORT IN SWEDEN FOR SCIENTIFIC PUBLICATIONS

By Dr. GÖSTA W. FUNKE

Secretary, Swedish Natural Science Research Council

FOR several years science in all civilized countries has enjoyed considerable Government interest—an interest which has, among other things, found expression in the placing at its disposal of considerable sums of money for apparatus, buildings, salaries, etc. On the other hand, very little seems as yet to have been done to facilitate the publication of the ever-increasing flow of the results of the research which has ensued as a consequence of improved conditions for scientific investigation. It is self-evident that facilities for publication must be expanded to keep pace with the expansion in scientific activity if the latter is to be fully utilized. That this fact is appreciated may be seen from the Royal Society Scientific Information Conference held last summer in London. At this Conference several speakers emphasized the necessity for Government measures to support publication, so as to complete the official steps which had already been taken for the benefit of science. Since Sweden has, by decision of the 1947 Riksdag, voted a grant for the publication of the results of scientific work, which is large in relation to the country's circumstances, a short summary of this measure may be of interest and provide a stimulus towards similar measures in other countries where there are corresponding requirements.

The grant in question is only intended for the publication of the results of basic research in the field of pure science; but it is hoped shortly to obtain a similar grant for technical and medical research, etc. The grant amounts to 300,000 Swedish crowns (rather more than £20,000) per annum, and is administered by the Swedish Natural Science Research Council. For purposes of comparison, it may be stated that the Council has at its disposal for distribution in grants for actual research work the sum of 1,000,000 Swedish crowns (about £65,000) per annum. The proportion between grants for research and publication is thus approximately in the ratio of three to one, which shows the importance attached to the facilities for publishing the results produced by research.

For the administration of the grant the Council has set up a special Publications Committee, with representatives of scientific research workers, editors of periodicals, libraries, and printing specialists. The greater part of the grant is used to assist periodicals; but contributions are also made towards text-books and manuals, monographs, etc. A special item is the contribution towards the printing of doctorate theses, of which the expense had formerly, to a large extent, to be borne by the writers of the theses themselves.

It has been possible to start several new periodicals with the help of this grant, as, for example, *Acta chemica scandinavica*, *Tellus* (a geophysical periodical), *Physiologia plantarum*, *Oikos* (a periodical devoted to ecology), and to expand those already in existence. It is the intention of the Council to support only periodicals of international standing. The new periodicals have therefore generally come into existence with the collaboration of, and financial contributions from, the other Scandinavian countries, Denmark, Finland and Norway. In order to promote their circulation abroad, it is stipulated that articles in those periodicals assisted by the Council shall for the most part be written in English, French or German. The Government grant also enables the Research Council to consider other forms of publication.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, April 19

Society of Chemical Industry, Agriculture Group (in the Chemistry Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. S. J. Watson: "The Chemistry of Ensilage".

Tuesday, April 19—Saturday, April 23

South-Eastern Union of Scientific Societies (at the King's School, Canterbury).—Fifty-third Annual Congress.

Wednesday, April 20

At 8.30 p.m.—Mr. F. H. Edmunds: "Geological Surveys and their Influence" (Presidential Address).

Friday, April 22

At 7.45 p.m. (at the Chapter House).—Young Naturalists' Evening.

Wednesday, April 20

Royal Institute of Chemistry, London and S.E. Counties Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 3 p.m.—Symposium on "Standardisation in the Chemical Field".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. G. E. R. Deacon, F.R.S.: "Waves and Swell" (Symons Memorial Lecture).*

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. J. Gough and Mr. J. E. Wentworth: "The Use of Thin Sections of Entire Organs in Morbid Anatomical Studies"; Mr. E. W. Taylor: "The Phase-Contrast Microscope with particular reference to Vertical Incident Illumination".

Wednesday, April 20—Thursday, April 21

Society for General Microbiology (at the Royal Institution, Albemarle Street, London, W.1).

Wednesday, April 20

At 11 a.m.—Symposium on "The Nature of the Bacterial Surface".

Thursday, April 21

At 10 a.m.—Scientific Papers and Demonstrations.

Thursday, April 21

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Messrs. H. R. Potts and E. G. Lawford: "Recovery of Sulphur from Smelter Gases by the Orkla Process at Rio Tinto".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "Semi-Conductors and Rectifiers" (Fortieth Kelvin Lecture). (To be repeated on Monday, May 2, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. E. W. R. Steacie: "Gas Phase Reactions of Organic Radicals".* (Further Lectures on April 22 and 25.)

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. George Polya (Stanford University): "The Variation of a Circle".* (Further Lecture on Friday, April 22.)

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Discussion on "Frequency Modulation and Amplitude Modulation" (to be opened by Mr. C. E. G. Bailey and Mr. J. R. Brinkley).

ROYAL AERONAUTICAL SOCIETY (at the Municipal College, Portsmouth), at 7 p.m.—Mr. R. R. Duddy: "High Lift Devices and their Use".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Scientific Study of Paintings" (to be opened by Mr. F. I. G. Rawlins, Dr. H. J. Plenderleith and Mr. S. Rees-Jones).

Friday, April 22

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Twenty-seventh Annual Corporate Meeting; at 12 noon.—Mr. H. W. Cremer: "Scientific Communication" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 25th Duddell Medal, Prize and Certificate to Prof. K. M. G. Siegbahn; Prof. Siegbahn: 25th Duddell Lecture.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the National Hospital, Queen Square, London, W.C.1), at 5.30 p.m.—Messrs. T. Gold and R. J. Pumphrey: "The Theory of Hearing".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. E. G. Bailey (New York): "Invention and the Sifting Out of Engineering Facts" (James Clayton Lecture).

INSTITUTE OF METALS, BIRMINGHAM LOCAL SECTION (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6.30 p.m.—Dr. W. H. J. Vernon: "Corrosion".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. J. D. Kendall: "The Chemistry of Photographic Sensitizing Dyestuffs".

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Mr. R. J. Callow: "Opal Glasses".

Friday, April 22—Sunday, April 24

PREHISTORIC SOCIETY (at, and in conjunction with, the UNIVERSITY OF LONDON INSTITUTE OF ARCHÆOLOGY, Inner Circle, Regent's Park, London, N.W.1).—Conference on "Prehistoric Houses and Farms, and some Later Comparisons".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT IN MATHEMATICS at the Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (April 23).

PUBLIC ANALYST AND AGRICULTURAL ANALYST—The Town Clerk, Town Hall, Manchester 2, endorsed 'Public Analyst' (April 23).

LECTURER IN CHARGE OF THE MINING DEPARTMENT at Canterbury Technical College—The Acting Chief Education Officer for Canterbury, 78 London Road, Canterbury (April 23).

SENIOR LECTURER IN THE TEXTILE DEPARTMENT, a LECTURER IN BIOLOGY (to teach two of the following: Zoology and Physiology to degree standard, and Bacteriology to intermediate standard), a LECTURER IN PHYSICAL CHEMISTRY (to teach up to degree standard), and a LECTURER IN PHYSICS (to teach Heat and Properties of Matter to degree standard)—The Acting Clerk to the Governors, Nottingham and District Technical College, Nottingham (April 23).

DIRECTOR OF THE CHEMICAL RESEARCH LABORATORY at Teddington—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2490 (April 29).

ASSISTANT LECTURER IN CHEMISTRY, a LECTURER IN PURE MATHEMATICS, an ASSISTANT LECTURER IN PHYSICS, and LECTURERS IN EDUCATION, with special qualifications in (*a*) Principles of Education with Classics, (*b*) Chemistry and Physics, (*c*) Geography—The Registrar, University College, Hull (April 30).

PHYSICISTS, MECHANICAL or ELECTRICAL ENGINEERS (Senior Experimental Officer grade) at the Royal Aircraft Establishment, Farnborough, and other establishments in South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.437/48A (April 30).

LECTURER IN PHYSICS at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1 (April 30).

LECTURER IN PHYSICS AND MATHEMATICS—The Registrar, Merchant Venturers' Technical College, Bristol (April 30).

RESEARCH STUDENTSHIPS IN EXPERIMENTAL or THEORETICAL PHYSICS—The Director, Wills Physical Laboratory, The University, Bristol (May 1).

LECTURER (Grade II) IN APPLIED MATHEMATICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 6).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (May 7).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (May 14).

PRINCIPAL SCIENTIFIC OFFICERS at a Ministry of Supply Research and Development Establishment near London: (*a*) Mechanical or Chemical Engineer (Ref. F.223/49A) for work on the design and development of rockets and associated problems; (*b*) Mechanical or Electrical Engineer (Ref. C.208/49A) for work on artillery equipments and associated engineering problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 14).

LECTURERS or ASSISTANT LECTURERS (3) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (May 14).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, The University, Manchester 13 (May 21).

RESEARCH FELLOWSHIP IN MATHEMATICAL PHYSICS, and an ASSISTANT LECTURER (Grade III) IN MATHEMATICAL PHYSICS—The Secretary, The University, Birmingham 3 (May 30).

JOHNSTONE AND FLORENCE STONEY STUDENTSHIP for research in biological, geological, meteorological or radiological science in Australia, South Africa or New Zealand, and a JUNIOR BRITISH SCHOLARSHIP for research or training for research—Research Applications, British Federation of University Women, Ltd., 17a King's Road, London, S.W.3 (May 30).

LECTURER or ASSISTANT LECTURER IN GEOLOGY—The Secretary, The University, Aberdeen (May 31).

BOOTS RESEARCH SCHOLARSHIP tenable at the Long Ashton Agricultural and Horticultural Research Station—The Secretary and Registrar, The University, Bristol (May 31).

LECTURERS and SENIOR LECTURERS IN PHYSICS—The Secretary of the University Court, The University, Glasgow, W.2 (May 31).

ROYAL SOCIETY, ARMOURER AND BRASIERS' COMPANY RESEARCH FELLOWSHIP IN METALLURGY—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 1).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Manchester 13 (June 18).

RESEARCH STUDENTSHIPS IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

LECTURER IN CHEMISTRY—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

POSTGRADUATE STUDENTSHIPS (3) FOR FISHERIES RESEARCH in the Colonial Empire—The Under Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

UNIVERSITY GRADUATES (with first- or second-class honours in Botany) for bracken investigations—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

SCIENCE GRADUATE as Scientific Assistant on the wood utilization side of the Bureau's scientific information service at Princes Risborough—The Director, Commonwealth Forestry Bureau, New Bodleian Building, Oxford.

EXAMINERSHIP IN BOTANY for Intermediate Examinations in the calendar year beginning January 1, 1950—The External Registrar, University of London, Senate House, London, W.C.1.

TEA RESEARCH OFFICER in Nyasaland to take charge of the existing Tea Experimental Station and also of the projected Tea Research Station—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN RUBBER TECHNOLOGY (knowledge of Plastics Technology essential)—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway Road, London, N.7.

HONOURS GRADUATE (with a first-class basic training in Chemistry or Biochemistry, or Chemical Engineering or Agricultural Chemistry) for training as a Fish Processing Expert—The Under Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ENGINEERS and PHYSICISTS IN THE ENGINEERING RESEARCH DEPARTMENT, based at Kingswood, Surrey—The Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1.

HEAD OF THE DEPARTMENT OF PHYSIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

LECTURER (Grade III) IN THE DEPARTMENT OF ZOOLOGY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Catalogues

Gallenkamp Thermostatic Bath. (Publication No. 513.) Pp. 2. Gallenkamp Laboratory Oven, No. 7840. (Publication No. 514.) Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1948.)

Bibliographies and Reference Books. (List 12.) Pp. 28. (New York: Herbert Reichner, 1948.)

Process Progress. Pp. 12. (Bromley: Wray (Optical Works), Ltd., 1948.)

Towers Isomantles. Pp. 8. Price List of Specialised Laboratory Organic Chemicals. (List No. 582.) Pp. 8. (Widnes: J. W. Towers and Co., Ltd., 1948.)

Sclex Bulletin. No. 3 Technical Series. Pp. 20. (London: Scientific Exports (Great Britain), Ltd., 1948.)